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CFAR
P.O. Box 1294
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9/30/02

SEP 2002
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EPA Region 8
999 18th St. Suite 300 8EPR-EP
Denver Co. 80202-2466

Dear Nat,

In March of this year, CFAR (Citizens For Accountability and Responsibility), a Dolores based group, was honored to be one of 30 groups across the U.S. to be awarded participation in the E.P.A. Office of Environmental Justice's Community Organization Summer Intern Program.

The goal of the study, designed and directed by Dr. Bill Jobin, an internationally recognized water quality specialist and Dave Wuchert, both CFAR members, was to identify contaminants in the upper Dolores River. Greg Hovezak, the chosen intern, was salaried through the grant. All other research participants were volunteers. Testing materials and equipment were funded by the dues and contributions of the CFAR membership, Montezuma County and the Dolores Water Conservancy.

Indicators were used in this preliminary study to reduce costs. Zinc is a general indicator of heavy metal and mercury contamination, thus the inexpensive Zinc test was used to show the most important sources of metals, which are the settling ponds and hot springs upstream of Rico and Silver Creek, which is just below the Blane Tunnel.

Based on the indication from Zinc concentrations, CFAR has started biological assessment of these two sources and will continue to measure biological effects through the autumn. Aquatic snails and other small organisms are being prepared for exposure in these sites and downstream. If significant mortality is found among these organisms, then some detailed chemistry will be conducted to determine the extent of heavy metal and mercury contamination downstream. The current and past transport of mercury downstream and to the floodplain and the impact of gravel mining on it's reactivation is a concern, since the EPA has identified significant concentrations of mercury in predatory fish in McPhee Resevoir. We expect to make a complete report on the heavy metals and bioassays in the late fall. We also look forward to continued monitoring in the future.

Total coliform bacteria counts were used as indicators of human contamination. In this case, there was a marked correlation between the presence of coliform bacteria and the RV parks and campgrounds. Although total coliform bacteria counts do not prove human contamination, they were found only where there was an RV park or campground directly upstream. Montezuma County and the town of Dolores should do their own intensive investigations of these sites. Since numbers of total coliform bacteria were very low, this is not an emergency, but deserves further investigation and consideration in future planning.

Our intent was to share the information gleaned from the study with interested parties. We encourage your participation and intervention in further exploration of data. Our funds are limited.

Enclosed, find a copy of the final report. Information is also available on the CFAR website at http://www.fone.net/~thovezak. Questions may be directed to Bill Jobin, 565-8331 or Dave Wuchert, 882-8081.

The EPA has presented CFAR with a Certificate of Appreciation in recognition of commitment to the protection and restoration of the nation's water resources.

Sincerely,

Pat Kantor

Pat Kantor, CFAR Pres.

Cc: Environmental Careers Organization
EPA
Montezuma County Commissioners
Dolores River Valley Working Group
Dolores Water Conservancy District
San Juan Citizens Alliance
Town of Dolores
Town of Rico
CDOW
CWQCD
Montezuma County Septic Inspector

Water Quality Study: Dolores River 2002

by Citizens For Accountability and Responsibility (CFAR)

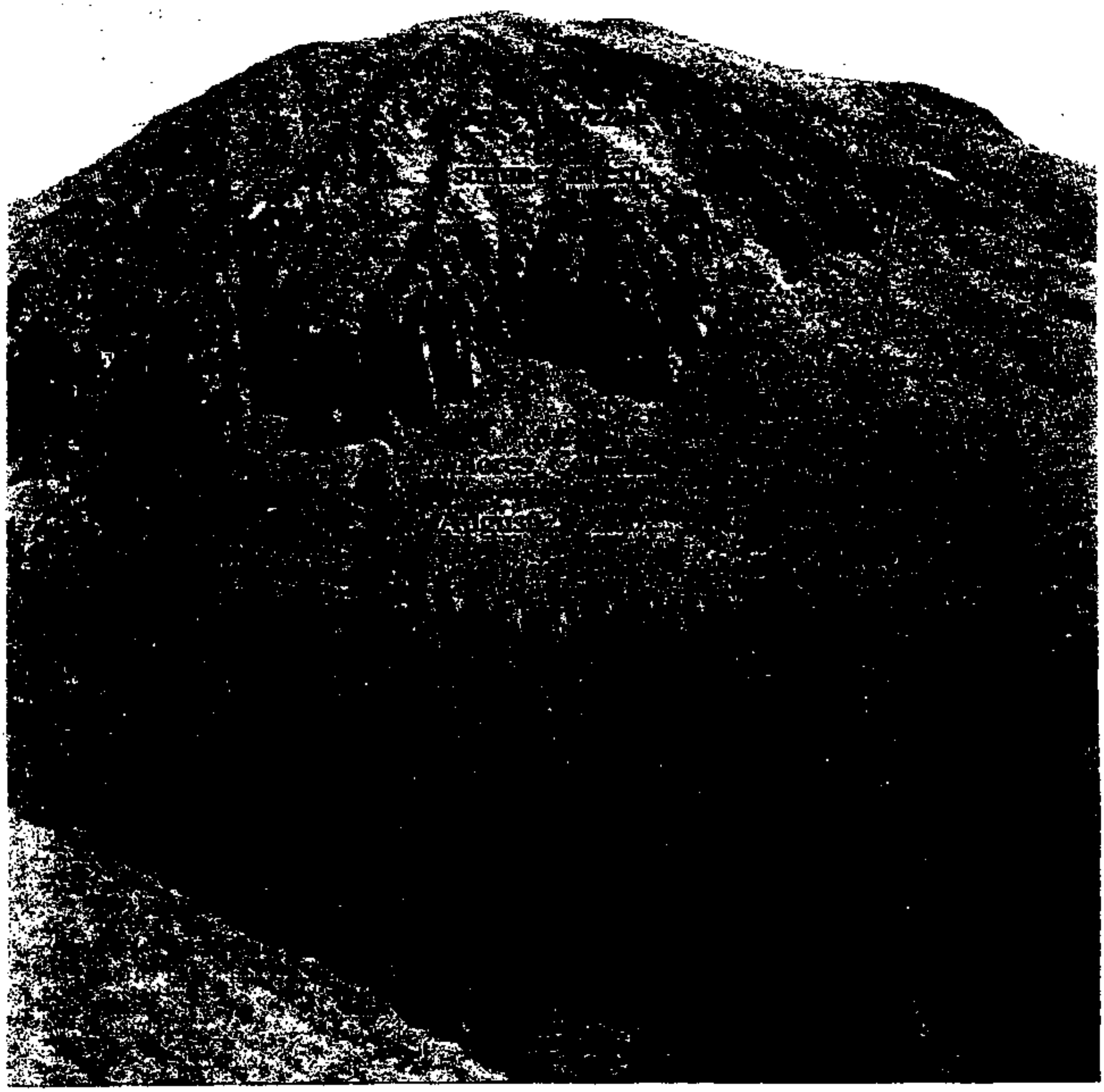


Table of Contents

Water Quality Study: Dolores River 2002
by Citizens For Accountability and Responsibility

Abstract

This Water Quality Study: Dolores River 2002, is a part of the larger Citizens For Accountability and Responsibility (CFAR) Summer Internship Project, partially sponsored by the Environmental Careers Organization (ECO) and the Environmental Protection Agency (EPA). The Water Quality Testing Study was designed to help protect water quality in the upper Dolores River drainage basin by establishing simple baseline data for the upper Dolores River and detecting and locating point sources of various types of water pollution. The conclusions drawn from this study are: (1) water quality in the Dolores River is good, (2) flows have a direct impact on concentrations of dissolved solids, (3) hard rock mineral mining pollution can be detected by small but perceptible changes in basic water quality factors, (4) as a result of high temperatures rainbow trout may be eliminated in the lower Dolores River, and (5) recommended future studies on biological impacts of metals are suggested.

Credits

We would like to thank CFAR and ECO for making this excellent project a possibility. We would also like to thank the Montezuma County Commissioners, and the Dolores Water Conservancy District for their gracious donations to this project. CFAR president Pat Kantor and the CFAR Board of Directors have been very encouraging and supportive of this project. We would like to thank Jim Sisco for his donation to the project and Scott Clow, who provided a great deal of technical support. John Patton was kind enough to fly us over the river in his plane for the aerial survey and Kate Thompson took the wonderful pictures from that flyover. Susie Localio and Dave Wuchert assisted with the actual water quality testing, and I am grateful for their help. Most of all, we would like to thank the project advisors, Bill Jobin and Dave Wuchert, who worked countless hours of their time on behalf of this project. Dave also wrote Appendix B: Testing Equipment and Procedures.

Introduction:

Rio de Nuestra Senora de las Dolores, The River of our Lady of Sorrows, was named in the late 1760's by Spanish explorer Don Juan Maria de Rivera after two members of his expedition drowned while attempting to ford it. The Dolores River arises in the high snow fields and rocky expanses of the southwestern San Juan Mountains. From its high seat it flows nearly 250 miles and joins the Colorado River far to the north. The Dolores River is dammed in just one place, making the section downstream from McPhee Dam one of the longest pieces of dam-free river in the contiguous United States. The river is of great scenic, natural, mineral, and material value, as well as being a source for that ever precious resource in the West: water. All along its length, people rely on the Dolores River for life.

The East, or Main Dolores River arises in Tin Can Basin at the foot of Grizzly Peak (Figure 1). It flows for about 54 miles before it enters McPhee Reservoir. The town of Dolores is just upstream from the reservoir and is the biggest population center in the project area (Figure 2). Rico, the only other incorporated town in the project area, lays about 14 miles downstream from the headwaters of the East Dolores (Figure 3). Approximately 40 miles below the headwaters is the confluence of the West Dolores River and the East Dolores River (Figures 4, 5). Together they form the Dolores River. The West Dolores River arises in Navajo Basin, in the shadow of El Diente, Mount Wilson, and Wilson Peak, all 14,000 foot high mountains (Figure 6). Near its source, the river flows into Navajo Lake, the largest natural lake in the project area. A historic mining town, Dunton, is about 9 miles from the West Dolores River headwaters. The total length of the West Dolores River is about 33 miles.

El Diente Peak (left) and Mount Wilson (right) from the South

From the head of McPhee Reservoir to McPhee Dam, the edge of the project area, it is about 10 miles. The project area, which encompasses all of the land drained by the Dolores River all the way to McPhee Dam, has a circumference of about 160 miles.

The two forks of the Dolores River have similar flows, the East being slightly larger, so the river doubles in size after the confluence. Mean river flows at the town of Dolores range from

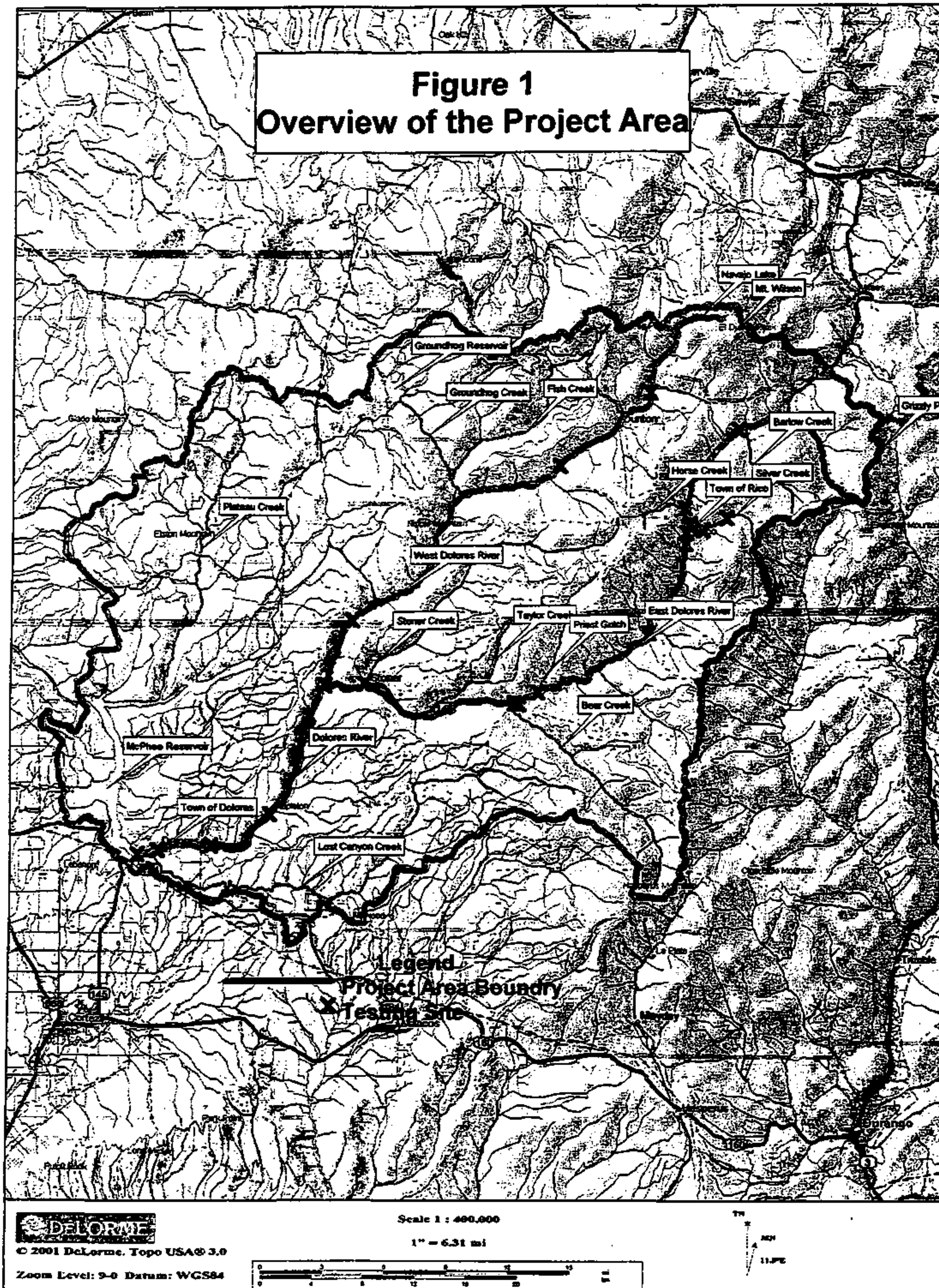


Figure 1
Overview of the Project Area

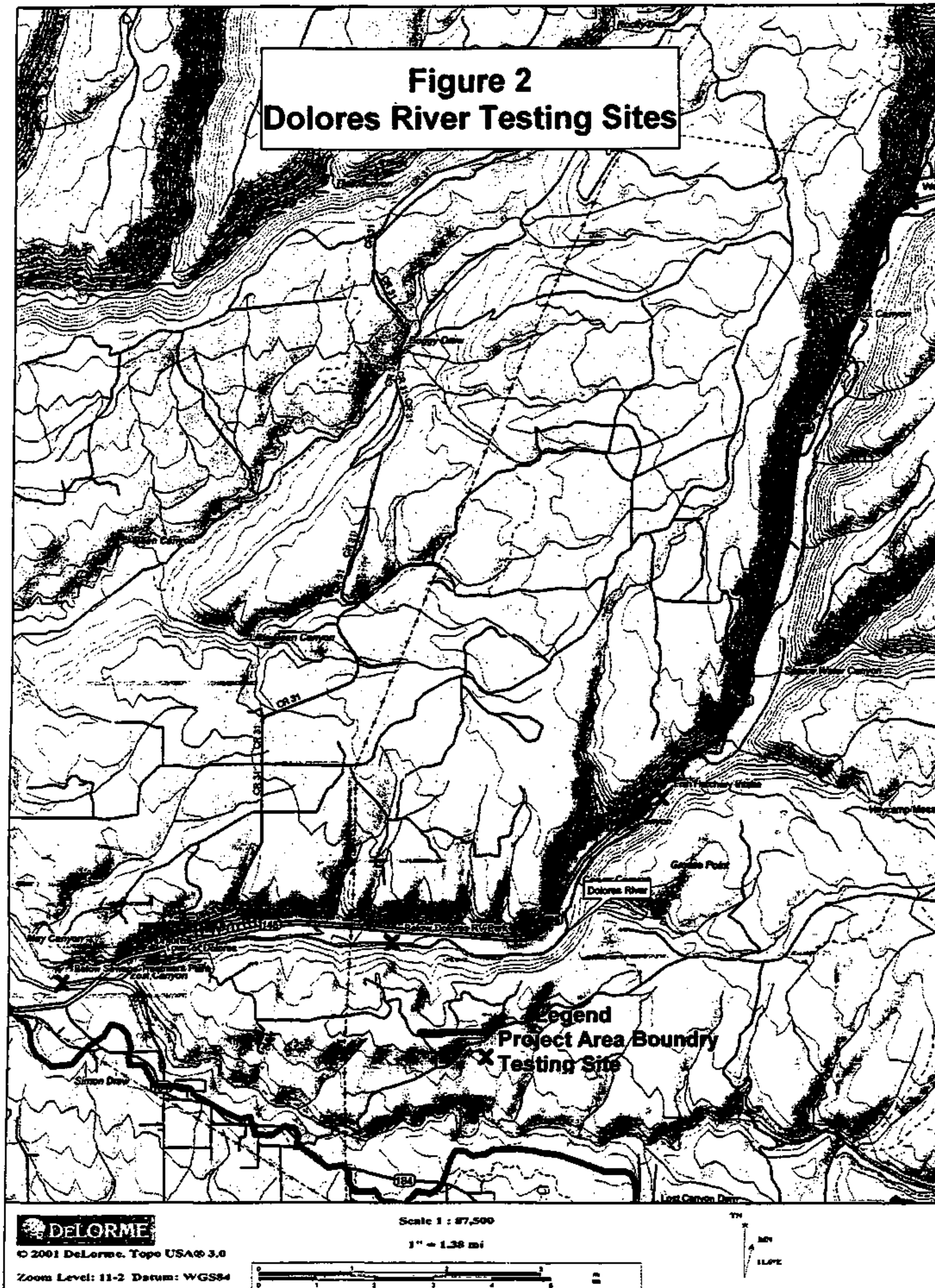
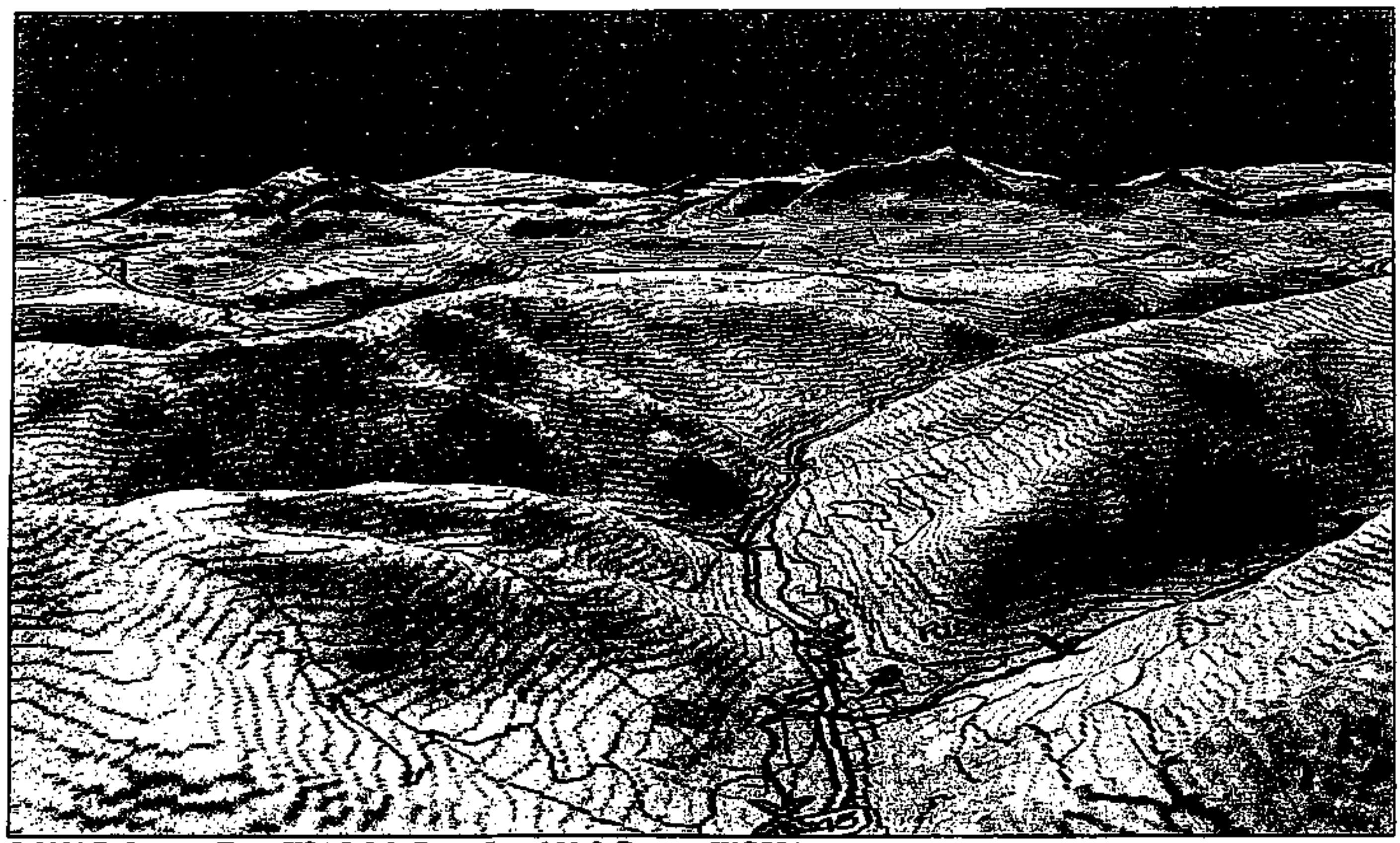


Figure 2
Dolores River Testing Sites

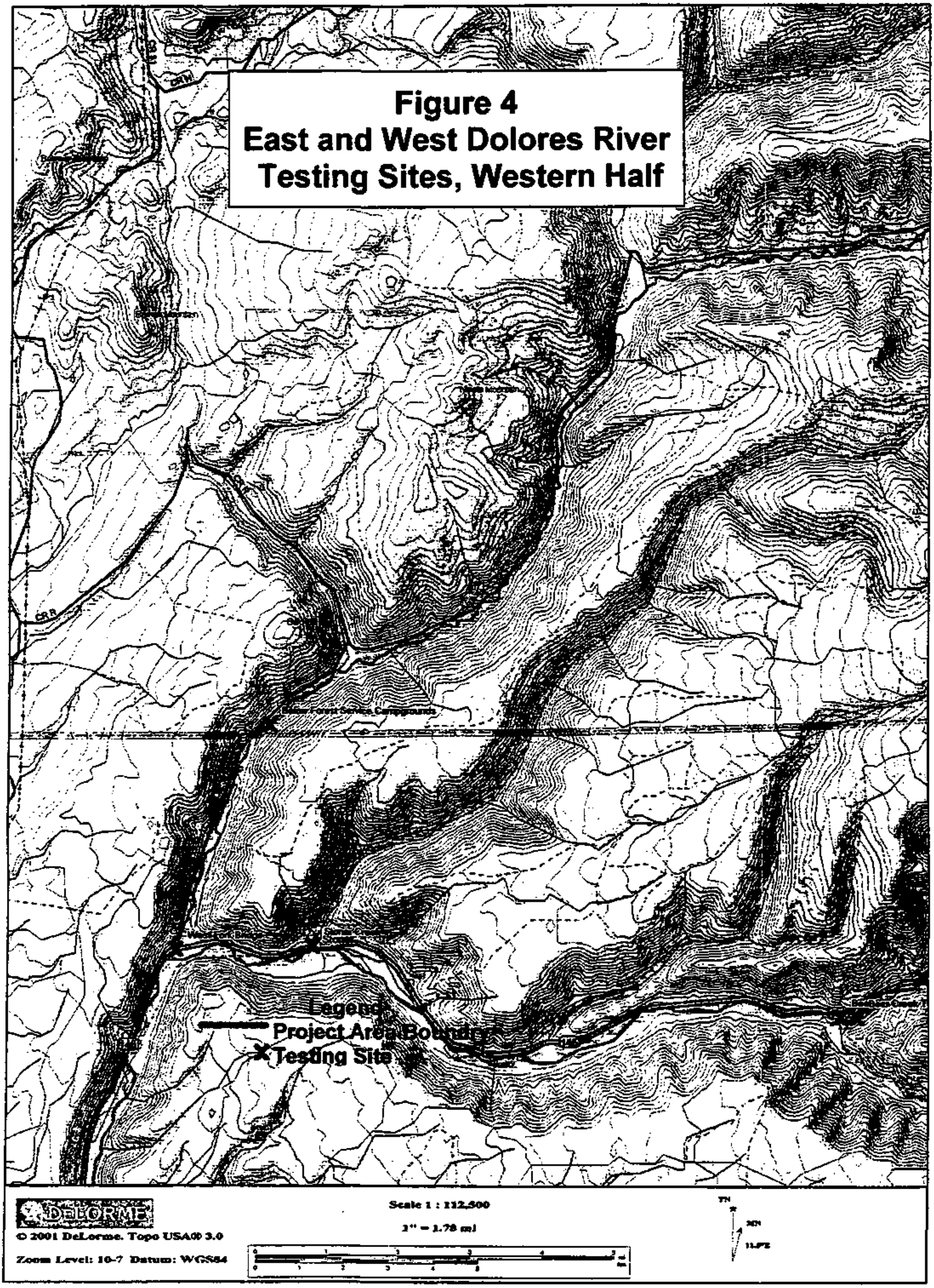
Figure 3

Three Dimensional rendering of the Rico Area.



The Town of Rico can be see in the lower right hand corner. It is marked with a blue pin. Our water quality testing sites are marked with red X's. All of the sites in the Rico area can be seen. Refer to Figure 5 to identify them. The highest mountains on the horizon are El Diente Peak and Mount Wilson.

Figure 4
East and West Dolores River Testing Sites, Western Half



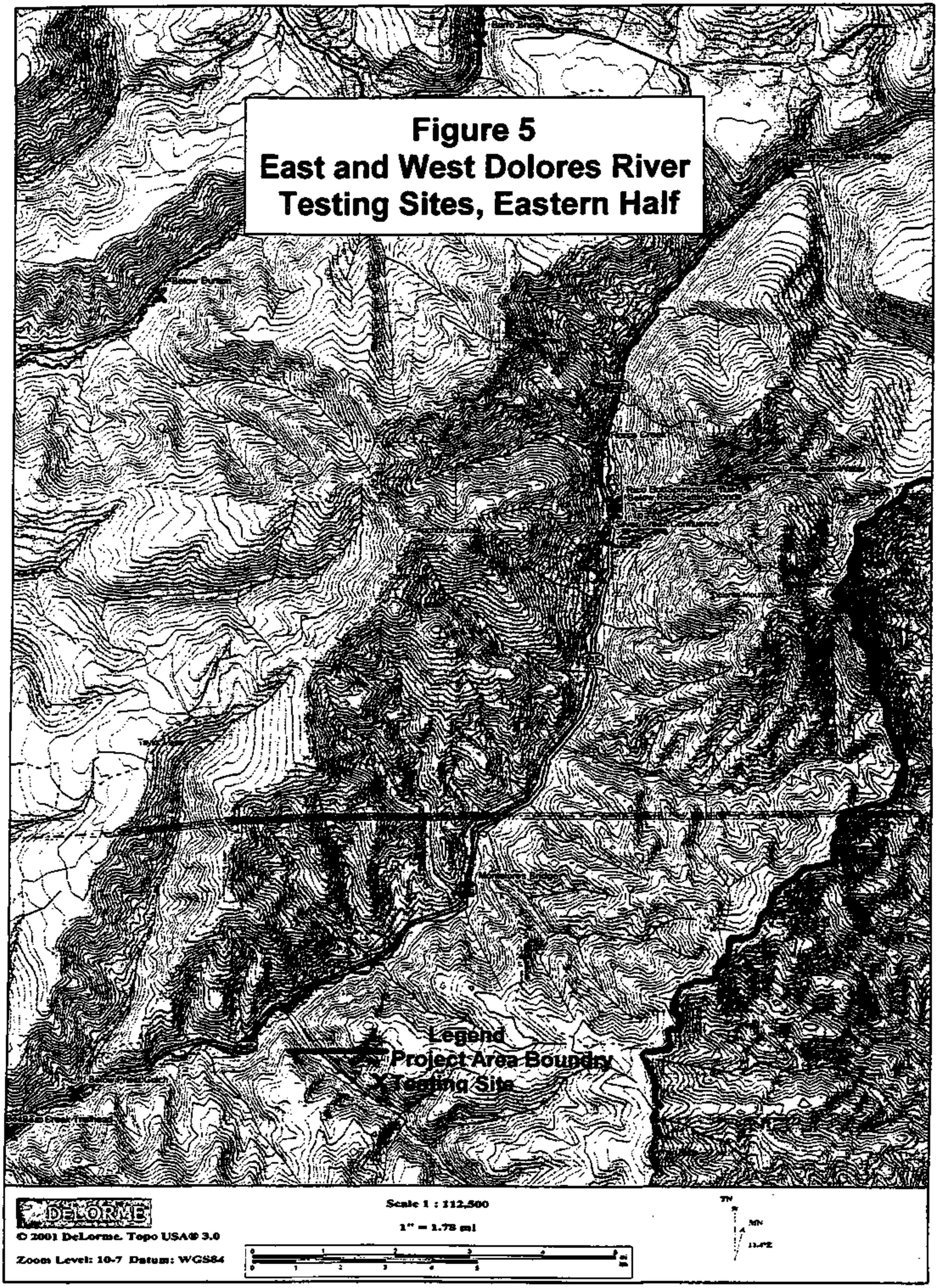
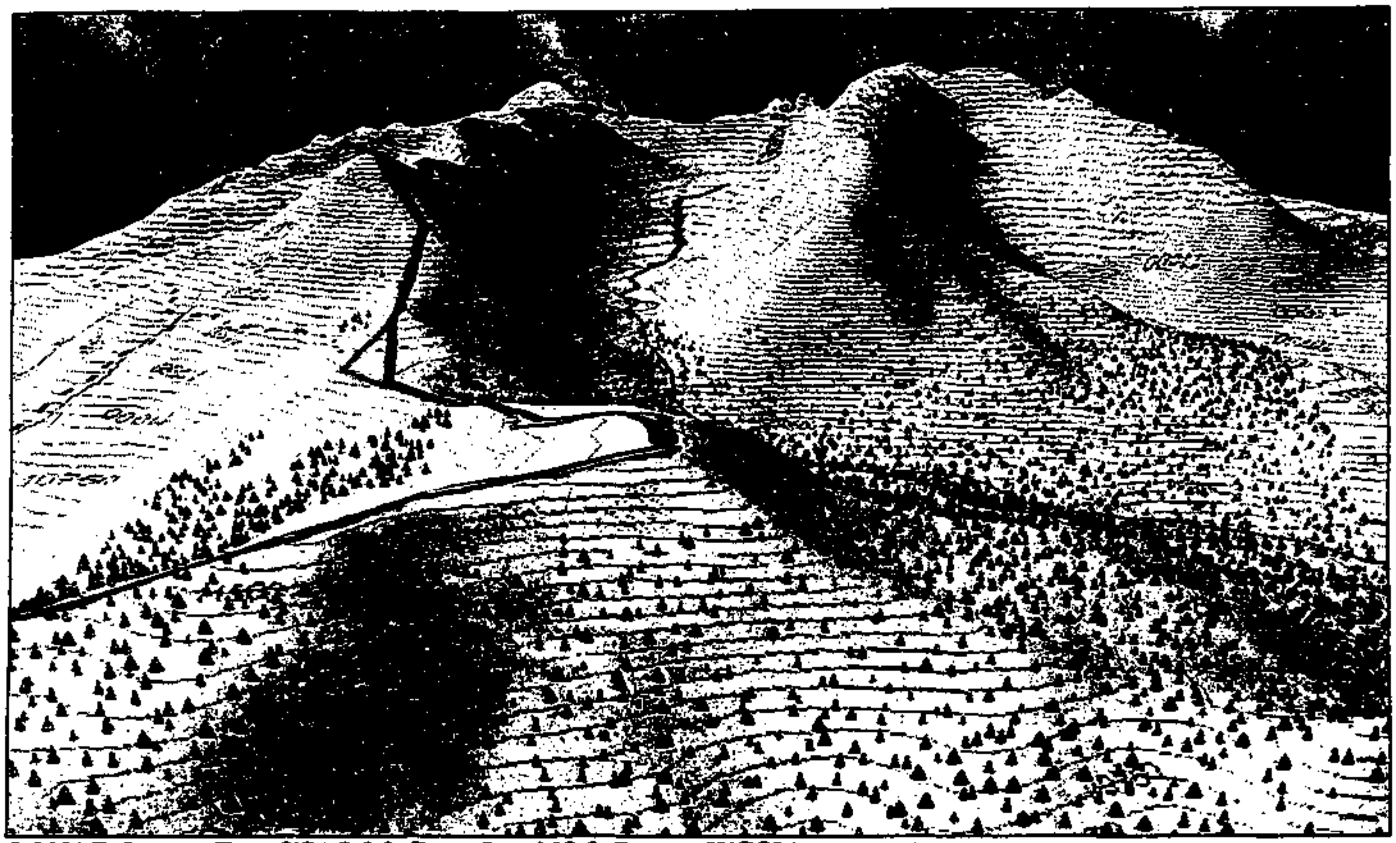


Figure 5
East and West Dolores River
Testing Sites, Eastern Half
Legend
Project Area Boundary
X Testing Site
DELORME
© 2001 DeLorme. Topo USA® 3.0
Zoom Level: 10-7 Datum: WGS84
Scale 1 : 112,500
1" = 1.78 mi

Figure 6

Three dimensional rendering of the headwaters of the West Dolores River

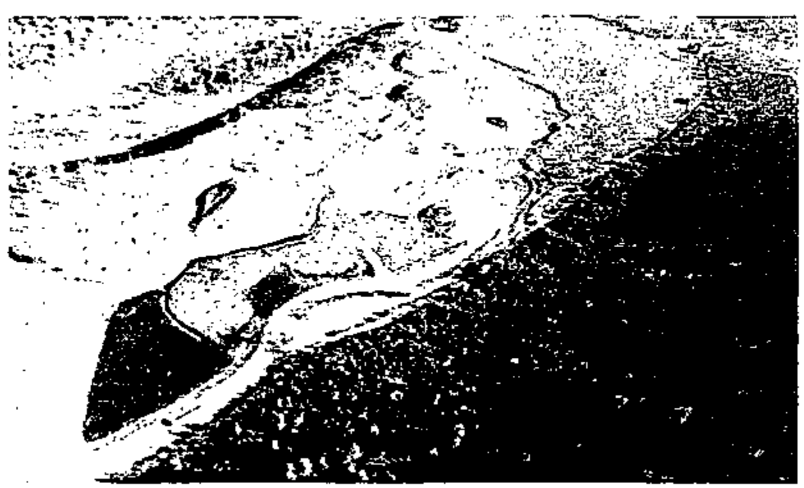


This rendering looks up the length of Navajo Basin, the headwaters of the West Dolores River. The project area boundary is the thick red line on the left side of the image.

several thousand cfs (cubic feet per second) during a typical spring flood to today's (08/19/02) record low of 4.9 cfs, depending on season and weather factors.

The Rico Mountains, between the branched arms of the upper Dolores River, was the site of one of Colorado's last gold and silver mining booms. Starting in the late 1870's thousands of miners poured into the area, forming the mining towns of Rico and Dunton and causing the creation of many surrounding towns to supply food and timber. Rico, the larger of the two, at one brief moment in history had a population of five thousand. That number abruptly decreased to one thousand after the devaluation of silver in 1893. Mining continued in Rico until the 1970's, when the last mining company pulled out of the area.

The Rico Mountains with the historic mining town of Dunton at their feet. The La Plata Mountains are in the distance.



A gravel mining operation in the Dolores River Valley

It is no longer gold and silver in the mountains, but alluvial deposits in the valley floor, that draws mining today. Open pit mining for gravel, mainly used for concrete aggregate and road base, now threatens the valley. Four major gravel pits have opened in the valley in the past decade. The Dolores River Valley also faces intensive pressure from housing developments and resorts, including a proposed "exclusive" golf course.

Citizens For Accountability and Responsibility (CFAR) organized in early 2000 in response to gravel mining in the Dolores River Valley. Conducting research to combat the gravel development led to a greater awareness of water quality issues among CFAR members. They realized that not only was there a shortage of data but that the available data was hard to access and utilize. Out of a desire to amend the data problem came the CFAR Summer Internship Project. This report is the summery of the CFAR Water Quality Study: Dolores River 2002, which is one section of the CFAR Summer Internship Project.

The confluence of the East and West Dolores Rivers looking downstream

The CFAR Summer Internship Project was designed with many goals in mind; to test the Dolores River and its tributaries in the project area at multiple sites and develop baseline data for the river, to identify point source pollution, and to inform the public about water quality in the project area. To accomplish this last goal a comprehensive water quality database was created and placed on a website (www.fone.net~thovezak), and a display board explaining the project was posted at the Dolores Town Hall.

The primary purpose of the Water Quality Study was to establish baseline data for basic factors at many sites along the length of the Dolores River. An equally important purpose was to locate point sources of various types of pollution. Peripheral purposes of the project include identifying what threats development of various types pose to the river. The methods, results and conclusions from the Water Quality Study are in this document.

Methodology:

The Tests

The tests chosen for primary use on the Water Quality Testing Project were for the most part simple and easy to perform in the field. Despite their simplicity, or perhaps because of it, they are basic indicators of stream health. The six tests chosen were coliform, elemental zinc, partial of hydrogen (pH), temperature, total dissolved solids (TDS), and total suspended solids (TSS). EPA water quality standards for the above parameters can be found in Table 1.

Coliform are bacteria that live in the intestines of many animals, including humans. Fecal coliform is the name ascribed to varieties living in the human gut. Though most coliform bacteria aid in digestion, some types are dangerous parasites. When they are ingested, either by drinking contaminated water or eating contaminated food, they can cause sickness or death. Due to the fact that so many people rely on the Dolores River for domestic water, coliform contamination is a serious issue. The coliform test used in this study is merely a predictor of the possible presence of fecal coliform. Coliform are measured by the number of bacteria in 100 milliliters of water.

Zinc is a heavy metal often found in close association with mercury and cadmium. Zinc is very toxic to aquatic life. While zinc has less of an effect on people than it does aquatic life its presence suggests that more dangerous mercury and cadmium may also be present. Our test measured zinc in parts per million (ppm), or the number of zinc atoms in one million molecules of solvent

This parameter, partial of Hydrogen, or pH as it is commonly called, measures the amount of hydrogen ions ($H+$) and hydronium ions ($OH-$) in solution. Acids, or substances that produce hydrogen ions when exposed to water, react with bases, or substances that produce hydronium ions in water. The pH scale ranges from 0 to 14, with neutral being 7. Less than 7 is an acidic solution while greater than 7 is a basic solution. Acids and bases are both corrosive. pH is important to water quality because aquatic life can only exist within certain parameters, generally close to neutral. The Environmental Protection Agency's (EPA) water quality standard for pH in freshwater is a range of 6 to 9 pH. Another reason that pH is so important to water quality is because it partially governs which form some heavy metals take. In other words slightly basic water helps to buffer against heavy metal load.

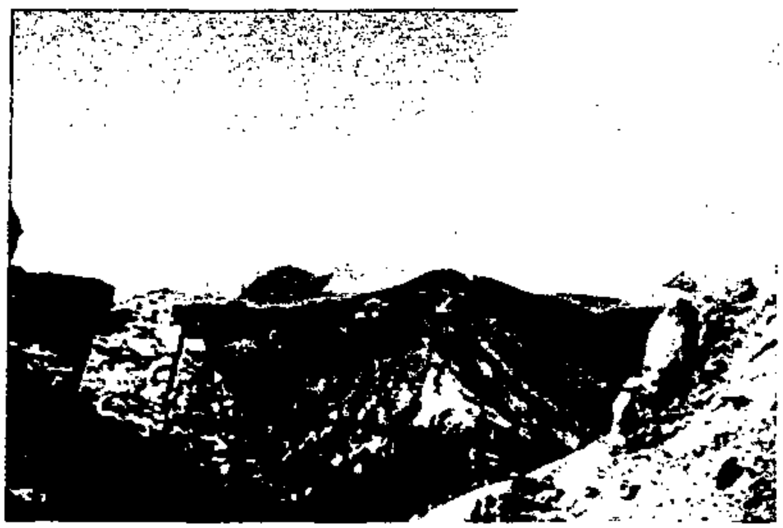
Total dissolved solids (TDS) is a measure of the amount of ions dissolved in solution. A good example of a dissolved ionic compound would be $NaCl$, or table salt. This is but one of many salts found naturally in water. Total dissolved solids are important to stream health because high levels of dissolved solids will kill aquatic stream life. Dissolved solids are also measured in parts per million.

Total suspended solids is a measure of the sediment suspended and carried by the turbulence of the water. The test we performed was designed to quantify how well sediment settling ponds work for gravel mining operations. Though we never had a chance to use it for such a purpose, it was also useful when applied qualitatively. Large amounts of suspended sediments can be detrimental to aquatic organisms, especially in clear running streams. Sediment can bury aquatic insect habitat and detrimental to aquatic organisms, especially in clear running streams. Sediment can bury aquatic insect habitat and destroy trout spawning gravels.

It should be noted that temperature values are highly dependant on the time of day and weather conditions. During the testing phase, due to various reasons such as time limitations, distance, and practicality, some testing sites were visited mainly during certain times of the day. This could affect averaged results in an adverse manner.

Locating Testing Sites

To locate testing sites (see Appendix A: Testing Site Information and Table 2) it was first necessary to determine possible "at-risk areas", and what the possible risk might be. Originally 8 areas were thought to possibly be at risk.



Mines around Rico

The first area was in the vicinity of the Town of Rico and the potential risk came from the mine wastes in the area. It was thought that several of the creeks in the area, as well as the river, were likely to be polluted with heavy metals. The creeks thought to be at risk were Burnett Creek, Horse Creek, and Silver Creek, as well as numerous smaller creeks and gulches. We located three testing sites on Silver Creek and one on Horse Creek. Silver Creek had far more mining activity than the other two creeks, enough so that it warranted three testing sites. Of the three testing sites on Silver Creek, one was a clean water site, the other was downstream from the greatest concentration of mining activity, and the third was in the town of Rico. One of the testing sites in the Rico area was a hot spring that flows out of a core sample drill hole into the river. The core sample was for the purpose of locating gold ore. It was tested because of the large amounts of mineral buildup wherever the water from if flowed. Another test site was located on a flume that drained mining wastewater effluent from settling ponds into the East Dolores River. This was tested in order to determine to what degree settling ponds filtered out pollutants. A test site was located below the settling ponds on the river and another test site was located just downstream of the town of Rico. A final test site was located several miles downstream to discover the cumulative effect of all the mines on water quality.

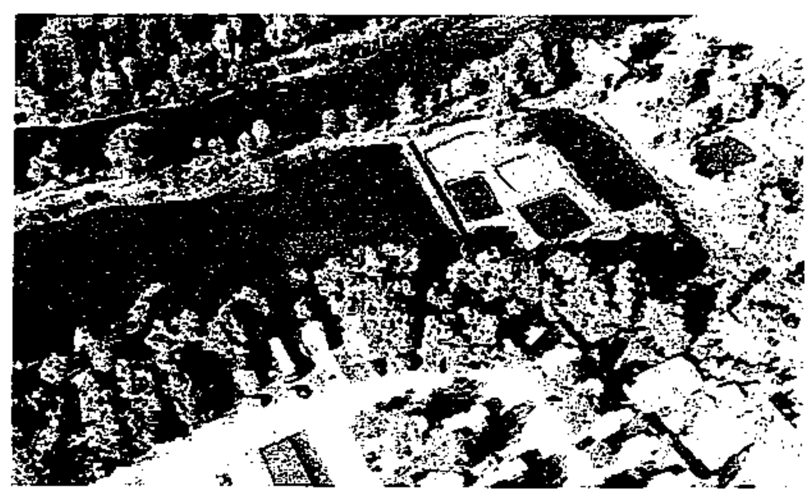
The next at risk area is downstream from the town of Rico and the threat was from fecal coliform contamination. The town of Rico lacks a water treatment plant so human waste in Rico is mostly handled by sewer systems. Due to the rocky soil and large number of households (200?) in such a small area, the risk of the river being contaminated with fecal coliform is very high. To detect such contamination we tested for coliform at two sites: the confluence of Silver Creek and the East Dolores River, and below the town of Rico.

The next at risk area is downstream of Circle K Ranch and Priest Gulch RV Park. It was thought that such seasonal operations having so many people in such a small area could cause a potential threat of fecal coliform contamination. To test this hypothesis we tested for coliform below Priest Gulch. When this site was discontinued due to lack of public land access, we moved to Bear Creek Trailhead, about a mile downstream.

Another area of possible risk was Stoner Creek. This was due to the location of another RV park near the creek. We tested for coliform at one site on Stoner Creek.

The next at risk area was located around the mining town of Dunton, on the West Dolores River. There had been a great deal of mining in the area historically, so one site was tested on the West Dolores River down-river from Dunton.

The other area at risk on the West Dolores River is downstream of the United States Forest Service campgrounds Mavareeso and West Dolores. Due to the large number of people inhabiting them and the type of waste management system in use, this area was identified as being at possible risk for fecal coliform contamination. One test site was located downstream from the Forest Service campgrounds.



Sewage treatment facility at the Dolores RV Park

On the Dolores River we located two at risk areas. One was downstream from Dolores RV Park, a potential source of fecal coliform contamination. A test site was located just downstream from the RV park. The other at risk area was the town of Dolores. Due to the large amounts of people and the outdated sewage treatment system, it was believed that there could be fecal coliform contaminating the river. To test this hypothesis, one test site was located in the town and another was located just below the town and the sewage treatment facility.

In addition to the at risk area sites there were also several clean water sites and sites located in between the at risk areas. The three clean water sites were located above all at-risk areas on the West and East Dolores River, and Silver Creek. A clean water site is essentially a control to compare our other test sites against.

Data Storage and Manipulation

The data gathered in the field was first handwritten on special data-sheets created expressly for that purpose. These data-sheets were stored in a three ring binder notebook. The information collected in the testing notebook was date, time, TDS, TSS, PH, temperature, zinc, whether a coliform sample was taken, and notes on unusual occurrences and the weather. At the end of a testing week, or sometimes several testing weeks, the data in the testing notebook was transferred manually into a computer program: Microsoft Access version 2002. The data-sheets in the testing notebook were kept as backup copies.

Access 2002 was used for the permanent storage of data because it is the medium used by the Colorado Water Quality Database (Information Series 48) created by Jonathan M. Zook and Matthew A. Sares. The data was partially manipulated using Access 2002, but was analyzed and graphed using Microsoft Excel v7.0.

Software

A wide variety of software was used during this project. Microsoft Access 2002 and Microsoft Excel, mentioned above, were used for data storage and manipulation. This report was written on Corel Word Perfect version 7.0. DeLorme Topo USA 3.0 was used for producing the maps in this report.

Results:

For the most part the Dolores River is a very clean stream, according to the data gathered by our testing program (Tables 3, 4). The water is cold and clear, aquatic insects teem in its waters, healthy riparian plants thrive on its banks, and trout swim its pools. It is the quintessential mountain stream. With a few exceptions, the other streams in the project area are the same.

There were several discernable changes in water quality as the streams traveled down their respective valleys. On the West Dolores River and Silver Creek there was a very gradual increase in PH traveling downstream. The increase was never more than one whole number on the pH scale and generally ranged from about 8.0 to 8.8 (Figures 7, 8). Another inclination, found on all streams tested, and one to be expected, was an increase in temperature between the upstream site and the testing sites downstream (Figures 9, 10, 11). Dissolved solids at the testing site farthest upstream were generally low, in the one hundreds, and then not far downstream show an increase to around three hundred ppm. The concentration of dissolved solids then leveled out or showed slight increases or decreases (Figures 12, 13, 14). Dissolved elemental zinc was, at all times on the main-stem of the Dolores River, a trivial 0.1 ppm. It should be noted that 0.1 was the detection limit of the zinc test we performed and actual values may be much lower.

Looking up Navajo Basin, the headwaters of the West Dolores River. From left to right are Wilson Peak, Gladstone Peak, El Diente, and Mount Wilson

This year is the driest on record, and the rivers have suffered accordingly. For example, the average river flows for August 19th are about 200 cfs. This year on August 19th the river flow is 4.9 cfs. This is by no means an average year (Figures 15, 16).

During mid-July a large release of water from Groundhog Reservoir into the West Dolores River (via Groundhog and Fish Creeks) gave us a chance to observe the effects of flood conditions on the river. The sites affected showed a decrease of total dissolved solids from around 300 ppm to about 150 ppm during the height of the releases (Figure 17). After the releases were finished and the river subsided, levels of total dissolved solids returned to their former values.

Wherever any decrease in water quality appears, it contrasts greatly from the areas with clean water. Such places are lower Silver Creek and the East Dolores River around the town of Rico. Analysis of the data from these areas shows some interesting anomalies.

In past years, Silver Creek, a mountain stream draining the East Rico Mountains, was the site of the most intense mining activity in the project area. At our clean water site, above the area of mining activity, Silver Creek is overhung with vegetation and populated by a wide variety of aquatic insects. Just over one mile below our clean water site on Silver Creek, inside that area affected by historic mining activity, the wide creek bed is devoid of aquatic life. The rocks in this stretch are coated with a thick patina of reddish orange mineral deposits. In the 1.32 mile stretch of Silver Creek between the clean water site, and the next downstream testing site, the pH decreases very slightly (Figure 8), the total dissolved solids more than double (Figure 14), and the concentration of dissolved elemental zinc increases by more than ten times (Figure 18). At the next test site the levels of dissolved elemental zinc drop. This drop is probably due to dilution from side streams with low levels of zinc.

The stretch of the East Dolores River several miles above and below the town of Rico also has had significant mining activity. Just above the town of Rico is the St. Louis Tunnel, the last mine in the project area to close. There is some staining on the river cobbles in this section, and the river shows the same anomalies as Silver Creek exhibited. The pH in this section of the river decreases to an average of 7.2, significantly lower than the pH of 8.26 at the clean water testing site, Barlow Creek Bridge, about 5 miles upstream. The pH of the river rises to near its clean water concentration after it exits the Rico area (river mile 34.0) (Figure 19). The total dissolved solids also increase at Rico to an average of 337 ppm, a value over twice the level of dissolved solids at the clean water testing site. Downstream from Rico, this high value subsides somewhat, probably from dilution (Figure 12). The zinc levels in this section remain the same as in the rest of the river, a steady value of 0.1 ppm. However, it seems probable that if greater test sensitivities could be achieved we would discover that levels of zinc in the section of river around Rico are elevated when compared to levels of zinc in the rest of the river.

An area on the West Dolores River, downstream from the historic mining activity around the derelict town of Dunton, also shows some oddities. Just six miles from the clean water site where the concentration of dissolved solids is 94 ppm, the levels of dissolved solids increases by over five times to an average of 487.5 ppm (Figure 13). There is also a slight decrease in pH when the trend is to increase (Figure 7). At this site zinc is also at or below the detection limit.

Other sites of interest are the Rico hot spring and the Rico settling pond effluent. The Rico hot spring, completely described in Appendix A: Testing Site Information, flows from a core sample drill hole. It exhibits high temperature (43.4 degrees centigrade); to be expected, and levels of dissolved solids that are above 2,500 ppm. It also has an average pH of 6.4 and high levels of zinc (Tables 3, 4). The Rico settling pond effluent, a testing site located on the outlet flume of settling ponds designed to clean water coming out of the St. Louis Tunnel, also shows unusual levels of pH, zinc, and dissolved solids. The average pH of water exiting the settling ponds is 7.2, not an average value for pH on the Dolores River, but an acceptable one (Tables 3, 4). However, the levels of dissolved solids and zinc are a different matter. Dissolved solids in the flume average 1,415 ppm while zinc averages 0.74 ppm (Tables 3, 4). Though water quality is poor for these two sites, due to their low flow volume they do not contribute large amounts of pollutants to the Dolores River.

Our tests also detected total coliform bacteria at several sites on the river. Three of the highest counts obtained came from the West Dolores River, and these were attributed to a herd of cows in the water prior to the sample being taken. Discounting values from that singular occurrence brings the levels of coliform on that stretch of river down to an average count, ranging from 0/100 mL to just over 9/100 mL. Even after the data was modified, one of the West Dolores River testing sites, below the Forest Service campgrounds (river mile 3.83), still shows the highest level of coliform. Using the modified data the only other West Dolores River testing site that has coliform is above the West Fork bridge (river mile 0.18) (Figure 20).

The site with the second highest count is on the East Dolores River (7.2/100 mL) and comes from Stoner Creek (river mile 16.76). Another from below Dolores RV Park (river mile 7.04) is nearly as high. The two other sites where coliform bacteria were detected (both values were 3.2/100 mL) are Silver Creek confluence (river mile 39.76) and at the Department of Wildlife fish hatchery intake (river mile 7.19). Coliform was not detected at any of the other sites (Figure 21).

Though the tests we performed cannot distinguish between fecal coliform and other types, it seems possible, given the high seasonal population density of the river valley, that some of the counts are from fecal coliform. If that is true, then there are several malfunctioning, leaking, or nonexistent waste treatment systems. Some of the places we are concerned about fecal coliform contamination are below RV parks and campgrounds. It seems our concern may be justified considering that the three highest coliform counts came from below the United States Forest Service Campgrounds Mavareeso and West Dolores, the Stoner Creek RV Park, and the Dolores RV Park. These sites are not necessarily shown to be point sources. It may be that coliform in their area comes from some other source.

The other high counts we obtained may have come from private waste treatment systems or some other source. It should be noted that the Town of Rico has no waste treatment plant and that all human waste in Rico is handled by private systems.

Due to extremely low water levels, the water temperature in the lower reaches of the project area reached record highs this year. The average temperature at the Town of Dolores testing site was 20.8 degrees centigrade (Figure 10). This value is an average; the river temperature recorded at this site almost reached 24 degrees centigrade. This value is the upper temperature range for rainbow trout survival. It may be that the high temperatures this summer caused or will cause stress to the fish, possibly resulting the destruction of the rainbow trout fishery in the lower Dolores River.

Discussion:

More information concerning water quality on the Dolores River may be found on the Environmental Protection Agency's (EPA) Storet database. A copy of the information on the Storet database may also be found on the CFAR web-site, the URL of which is http://www.fone.net/~thovezak.

Major Conclusions:

1. In the summer of 2002 the Dolores River, except for a few select areas, and most tributaries was a very clean body of water. Total dissolved solids, suspended solids, pH, zinc, and coliform bacteria counts were all within acceptable levels.

2. On the Dolores River, flows had a direct impact on the level of total dissolved solids. In other words, the greater the flows the less the dissolved solids and the less the flows the greater the level of dissolved solids. This was most likely a result of dilution by water containing a small amount of dissolved solids.

3. The presence of pollution associated with hard-rock mineral mining on the Dolores River was indicated by a slight decrease in PH, a relatively large increase in dissolved solids, and possibly the presence of large amounts of dissolved elemental zinc.

4. High temperatures in the lower Dolores River during the summer of 2002 may have resulted in the destruction of the rainbow trout fishery by heat stress.

5. Additional water quality testing is recommended for the upper Dolores River. Based on the chemical data we gathered during this project, particularly the high levels of zinc, we recommend that biological studies be done in the Rico area, especially on Silver Creek. In areas indicated by the biological testing, metal scans or selective heavy metal testing would help to further define the threats posed by mine waste. We would also recommend a continuation of the testing program designed for this project to further increase the baseline data for the upper Dolores River drainage basin. A continued objective of succeeding phases of this study will be to identify actual point sources of mine waste pollution in order to form a basis for enforcement action by State and Federal agencies.

Literature Cited:

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Appendices:

Appendix A: Testing Site Information

Site Name: Below Dolores Sewage Treatment Plant
UTM Coordinates: 4149445N 12 719175E
7.5 Series USGS Topographic Map: West Dolores, CO
Description: The test site is located on the Dolores River several hundred meters downstream from the Town of Dolores sewage treatment facility. The test site is located on land that is beneath the high water mark of McPhee Reservoir and is thus presumably under the jurisdiction of the Colorado Bureau of Reclamation.

Site Name: Dolores RV Park
UTM Coordinates: 4150290N 12 724440E
7.5 Series USGS Topographic Map: Dolores East, CO
Description: The test site is just downstream of the Dolores RV Park, identified as a potential source of coliform bacteria. The test site is located on land owned by Mr. McCabe, who graciously allowed us to test on his property.

Site Name: DOW Fish Hatchery Intake
UTM Coordinates: 4152830N 12 729360E
7.5 Series USGS Topographic Map: Dolores East, CO
Description: The test site is located directly downstream from the diversion dam used by the Colorado Department of Wildlife to direct water into their fish hatchery ponds. This test site is located on land under the administration of the Colorado Department of Wildlife.

Site Name: Town of Dolores
UTM Coordinates: 4149875N 12 720790E
7.5 Series USGS Topographic Map: Dolores West, CO
Description: The test site is located on the Dolores River just upstream from the fourth street bridge. It is assumed that the test site, being directly adjacent to the bridge, is located on the road right-of-way.

Site Name: Barlow Creek Bridge
UTM Coordinates: 4184180N 13 236943E
7.5 Series USGS Topographic Map: Mount Wilson, CO
Description: The test site is just upstream from the Barlow Creek Road bridge crossing the East Dolores. The land is managed by the United States Forest Service.

Site Name: Bear Creek
UTM Coordinates: 4162260N 12 748360E
7.5 Series USGS Topographic Map: Wallace Ranch, CO
Description: The testing site is located at the confluence of the East Dolores River and Bear Creek on Bear Creek. Land ownership is unknown.

Site Name: Bear Creek Trailhead
UTM Coordinates: 4162210N 12 748860E
7.5 Series USGS Topographic Map: Wallace Ranch, CO
Description: The testing site is located on the East Dolores River at the United States Forest Service trailhead for the Bear Creek trail. The test site is located on Forest Service land.

Site Name: Below Rico
UTM Coordinates: 4175190N 12 761575E
7.5 Series USGS Topographic Map: Rico, CO
Description: The testing site is located on the East Dolores River at the downstream end of the town of Rico. The land is inside the municipal boundary and is presumed to be owned by the town.

Site Name: Below Rico Settling Ponds
UTM Coordinates: 4176375N 12 761830E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is located on the East Dolores River several hundred meters downstream from the last settling pond in a series that filters the effluent from the St. Louis Tunnel. Land ownership at the testing site is unknown.

Site Name: Horse Creek
UTM Coordinates: 4177865N 12 761430E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is located just upstream of the Hwy 145 crossing of Horse Creek. Due to the proximity to the highway it can be assumed that the test site is on the highway right-of-way.

Site Name: Montelores Bridge
UTM Coordinates: 4169845N 12 759910E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is approximately 300 meters upriver from the Montelores bridge on the mainstem of the East Dolores River. The river runs along the Hwy 145 and it can be presumed that the access is on the highway right-of-way.

Site Name: Priest Gulch
UTM Coordinates: 4163100N 12 750240E
7.5 Series USGS Topographic Map: Wallace Ranch, CO

Description: The test site sits several hundred meters below the entrance to Priest Gulch Campground on the mainstem of the East Dolores River. Land ownership is private.

Site Name: Rico Hot Spring
UTM Coordinates: 4176793N 12 761830E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is a small hot spring that appears to drain from a pipe sunk vertically into the ground. The pipe is the result of mining related core sampling. Mineral buildup from the spring has formed a small orange mound around it. The runoff from the spring is piped into a hot tub and from there into the river. There are at least two similar spring in the area and indications that there may be more. The hot spring is located on United States Forest Service land.

Site Name: Settling Pong Outlet Flume
UTM Coordinates: 4176773N 12 761840E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is the outlet flume for settling ponds designed to filter effluent from the St. Louis Tunnel. The flume flows out of the lowest pit directly into the East Dolores River and is located on United States Forest Service land.

Site Name: Silver Creek Clean Water
UTM Coordinates: 4176880N 12 764150E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is located on Silver Creek, several hundred meters above the place where the town of Rico draws its domestic water. The place is presumably on land under the jurisdiction of the National Forest Service. This site is the clean water site for Silver Creek.

Site Name: Silver Creek Confluence
UTM Coordinates: 4175895N 12 761590E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is on Silver Creek, just upstream from the confluence with the East Dolores River. Ownership certain is not certain.

Site Name: Silver Creek Culvert
UTM Coordinates: 4176190N 12 762870E
7.5 Series USGS Topographic Map: Rico, CO
Description: The test site is just upstream from an unidentified road that crosses Silver Creek. The road, like many others in the area, is associated with the mining and subsequent reclamation that took place at Silver Creek. It is assumed that the test site is on National Forest Service land.

Site Name: Stoner Creek
UTM Coordinates: 4163400N 12 736520E

7.5 Series USGS Topographic Map: Stoner, CO
Description: The testing site is located just upstream from where the Hwy 145 bridge crosses Stoner Creek. The testing site is in the highway right-of-way and should therefore be on property under the jurisdiction of CDOT. The confluence of the East Dolores and Stoner Creek is about 30 meters from the testing site. At this location Stoner Creek runs from roughly north to south while the river runs east to west. To the east of the testing site is the Stoner Cafe (and RV Park). To the west is a parking lot that provides access to a corral and is presumably public land.

Site Name: Below Dunton
UTM Coordinates: 4181425N 12 751620E
7.5 Series USGS Topographic Map: Clyde Lake, CO
Description: The test site is located on the West Dolores River near the road that leads to the Johnny Bull trail-head. It is assumed that the test site is on United States Forest Service land.

Site Name: Below Forest Service Campgrounds
UTM Coordinates: 4168340N 12 735375E
7.5 Series USGS Topographic Map: Nipple Mountain, CO
Description: The testing site is located on the West Dolores River near the parking lot of what used to be the Emerson campground. The test site is located on United States Forest Service land.

Site Name: Burro Bridge
UTM Coordinates: 4186960N 12 758430E
7.5 Series USGS Topographic Map: Dolores Peak, CO
Description: The test site is just upstream from the Burro Bridge crossing of the West Dolores River. The test site is on united States Forest Service land.

Site Name: West Fork Bridge
UTM Coordinates: 4163260W 12 733399E
7.5 Series USGS Topographic Map: Stoner, CO
Description: The test site is located just upstream from the Hwy 145 bridge that crosses the West Dolores River just above its confluence with the East Dolores River. The test site is assumed to be on the highway right-of-way.

Appendix B: Testing Equipment and Procedures

Zinc measurements were made with an Aquaquant test kit manufactured by EM Science. This is a color comparison method with a sensitivity of 0.1 to 5.0 ppm.

pH measurements were made with a portable Quikcheck pocket pH meter by Orion. Range is from 0.0 to 14.0 pH, with a resolution of 0.1 pH and an accuracy of 0.1 pH.

Total Dissolved Solids measurements were made with a portable TDS meter manufactured by Myron L Company with a range of 0 to 2500 ppm and a resolution of 50 ppm.

Total Suspended Solids were determined qualitatively by placing 1000Ml of water in a 1000ml in a graduated cylinder and letting it settle for approximately twenty minutes. Measurement resolution was 1.0 cc.

Coliform determinations were made with Millipore dip testers that were incubated for approximately 24 hours in a Lab-Line incubator.

Appendix C: Results Tables

Table 1	
EPA Water Quality Standards for freshwater	
Test	**Water Quality Standard**
Coliform Bacteria	1000/100 mL
Dissolved Elemental Zinc	0.12 ppm or 120.0 ug/L
Dissolved Solids	unknown
pH	6.5 - 9
Suspended Solids	unknown
Temperature	Species dependant

Table 2				
Testing Site Data				
TS* #	Station Name	River Section	River Mile	Body of Water
1	Barlow Creek Bridge	East Dolores River	46.00	East Dolores River
2	Horse Creek	East Dolores River	41.10 / 00.12	Horse Creek
3	Rico Hot Spring	East Dolores River	40.30 / 00.01	unnamed hot spring
4	Rico Settling Pond Effluent	East Dolores River	40.29 / 00.01	unnamed settling pond effluent
5	Below Rico Settling Ponds	East Dolores River	40.05	East Dolores River
6	Silver Creek, Clean Water	East Dolores River	39.76 / 02.18	Silver Creek
7	Silver Creek Culvert	East Dolores River	39.76 / 00.86	Silver Creek
8	Silver Creek Confluence	East Dolores River	39.76 / 00.01	Silver Creek
9	Below Rico	East Dolores River	39.17	East Dolores River
10	Montelores Bridge	East Dolores River	34.00	East Dolores River
11	Below Priest Gulch	East Dolores River	26.62	East Dolores River
12	Bear Creek	East Dolores River	25.10	Bear Creek
13	Stoner Creek	East Dolores River	16.76 / 00.03	Stoner Creek
14	Burro Bridge	West Dolores River	40.59 / 26.20	West Dolores River
15	Below Dunton	West Dolores River	34.45 / 20.06	West Dolores River
16	Forest Service Campgrounds	West Dolores River	18.22 / 03.83	West Dolores River

Testing Site Data				
TS* #	Station Name	River Section	River Mile	Body of Water
17	West Fork Bridge	West Dolores River	14.57 / 00.18	West Dolores River
20	Fish Hatchery Intake	Dolores River	07.19	Dolores River
21	Below Dolores RV Park	Dolores River	03.09	Dolores River
22	Town of Dolores	Dolores River	00.62	Dolores River
23	Below Sewage Plant	Dolores River	-00.38	Dolores River
24	Bear Creek Trailhead	East Dolores River	25.50	East Dolores River

Table 3					
Average Data for Each Test Site					
TS* Number	pH	Temperature, C°	Coliform, /100 mL	Zinc, ppm	TDS, ppm
1	8.26	13.66		0.1	132.5
2	8.2	12.64		0.1	150.7
3	6.4	43.4		0.36	2500
4	7.2	19.3		0.74	1415
5	7.2	17.66		0.1	336.6
6	8.07	8.98		0.1	127.5
7	8.06	12.32		1.14	312.5
8	8.36	15.66	3.162	0.48	381.8
9	7.46	16.52	0	0.1	299
10	8.35	15.2		0.1	298.3
11	8.16	15.5	0		262.5
12	8.2	13.1		0.1	130
13	8.4	16.48	7.169		170
14	8.08	13.18		0.1	94
15	8.06	19.58	0	0.1	487.5
16	8.38	19	9.283		220
17	8.41	18.22	3.76		282.1
20	8.45	19.7	3.162		225
21	8.28	20.7	7.04		230.7
22	8.38	20.8	0	0.1	224.3
23	8.33	21.32	0		234.3
24	8.42	16.8	0		265

Figure 7
Average pH of the West Dolores River

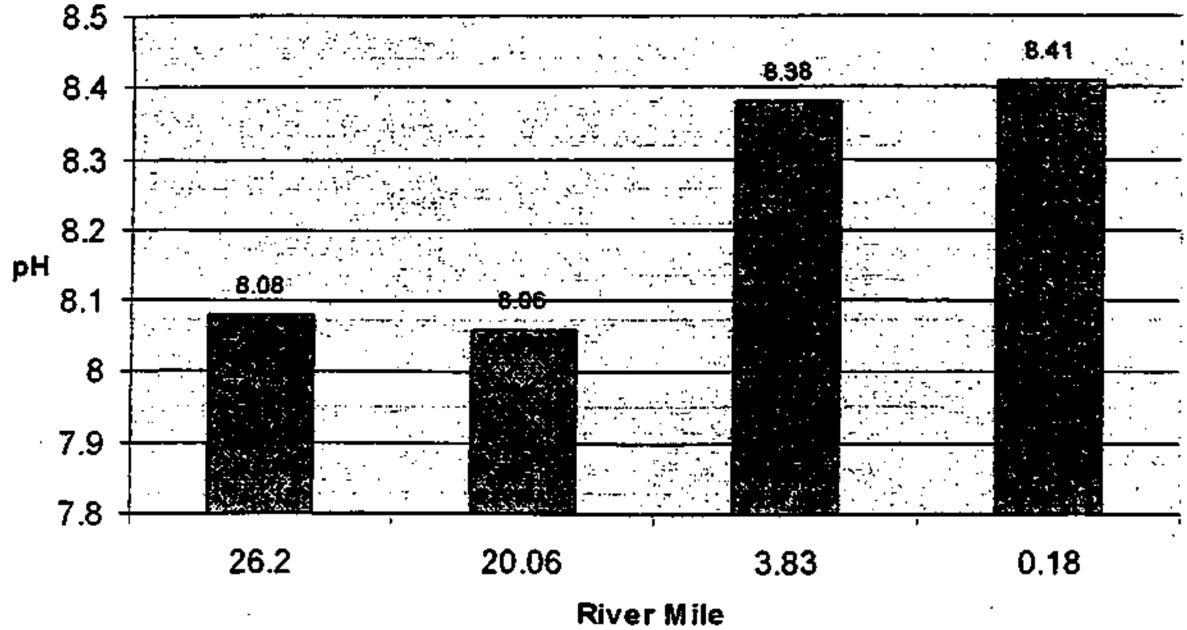


Figure 8
Average pH in Silver Creek

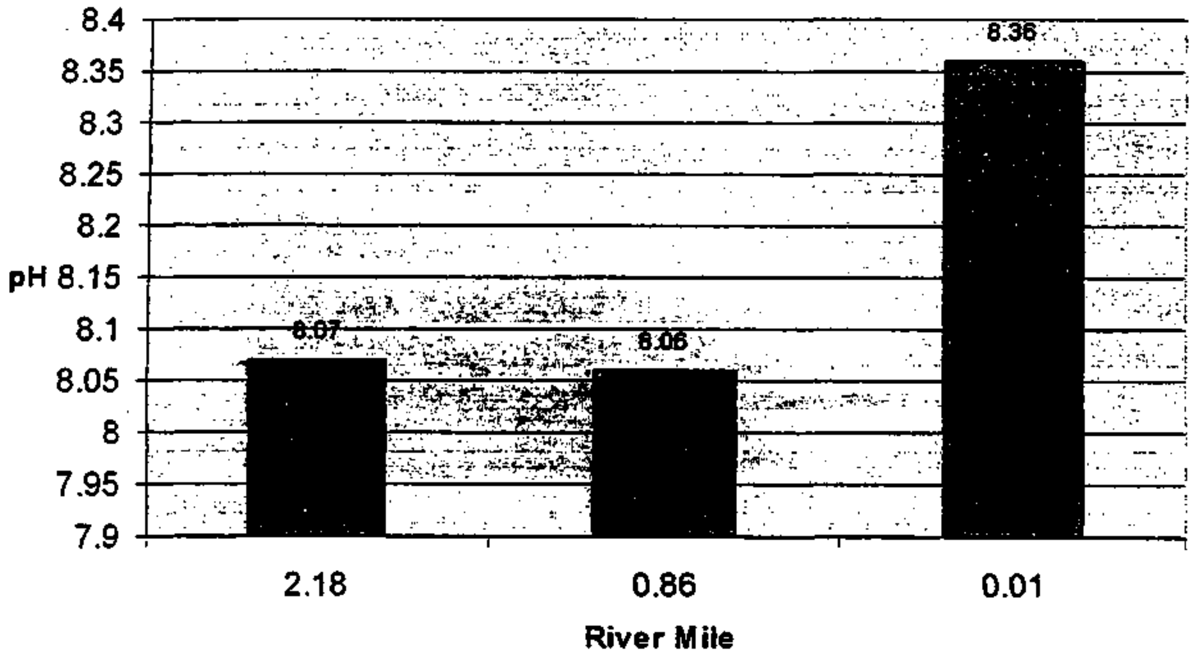


Figure 9
Average Water Temperature on the Main and East Dolores River

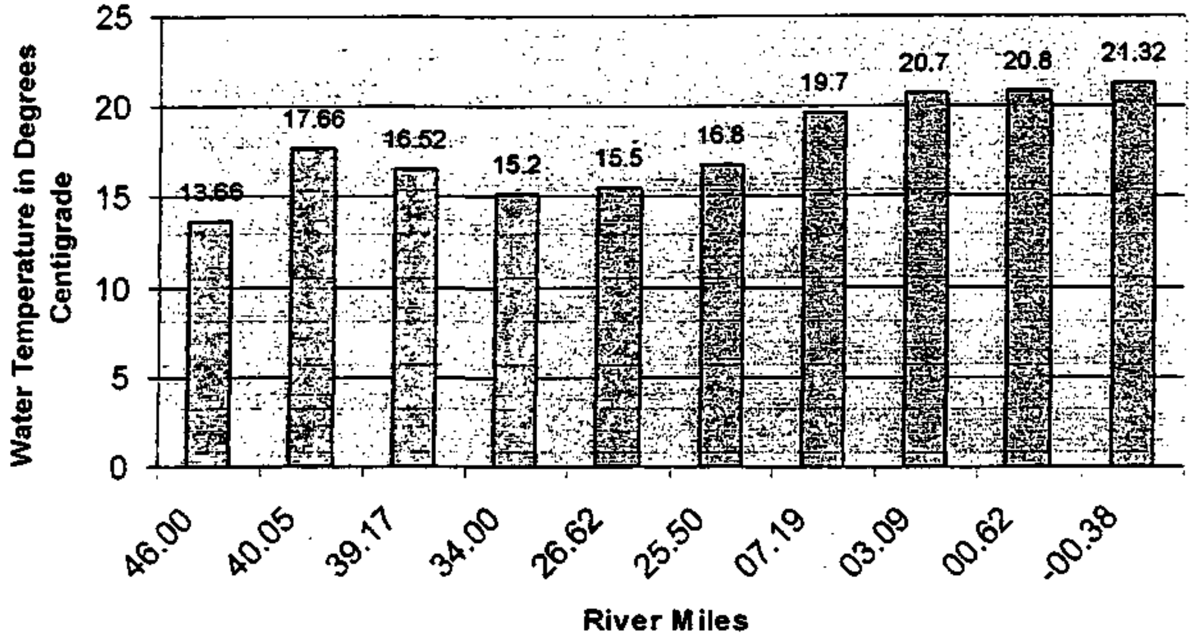


Figure 10
Average Water Temperature of the West Dolores River

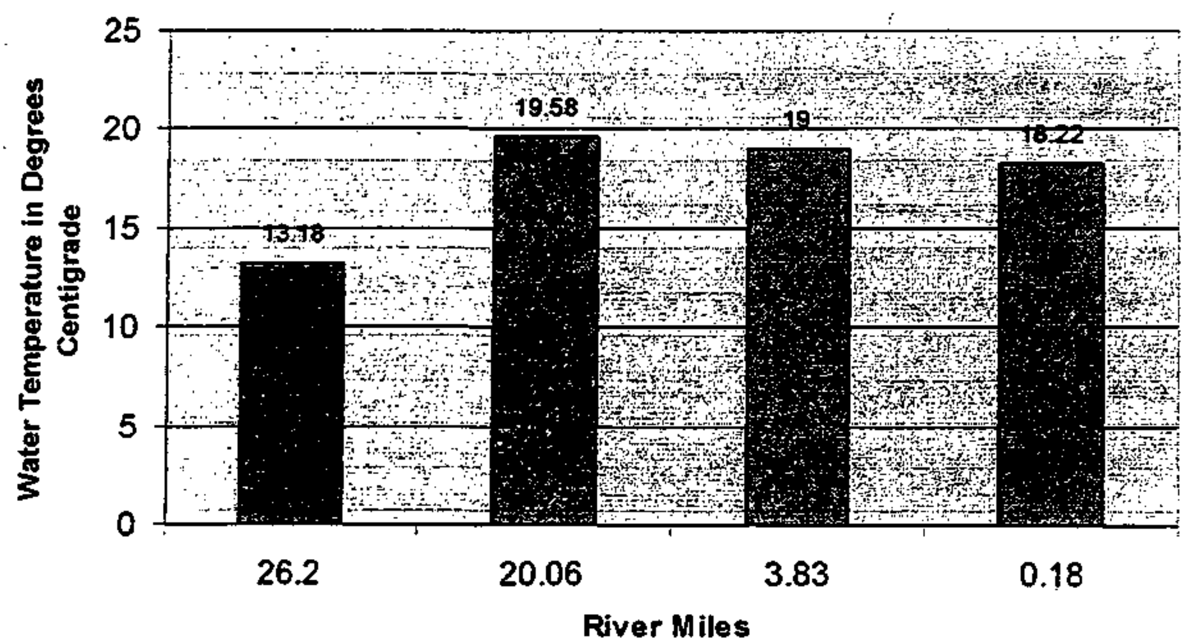


Figure 11
Average Water Temperature of Silver Creek

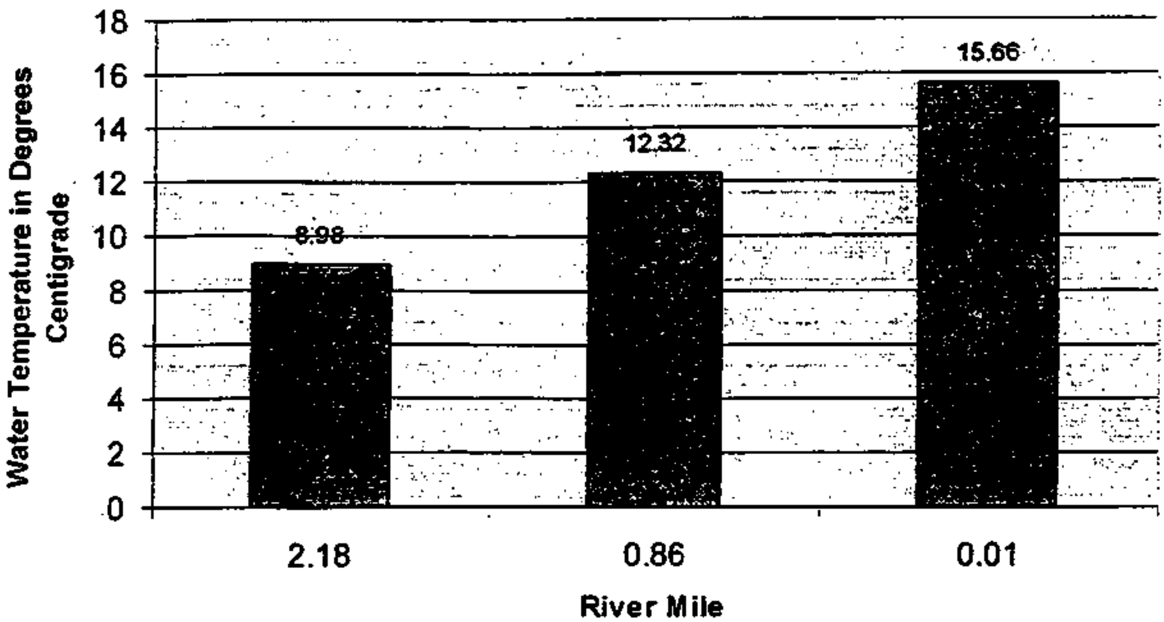


Figure 12
Average Total Dissolved Solids on the Main and East Forks of the Dolores

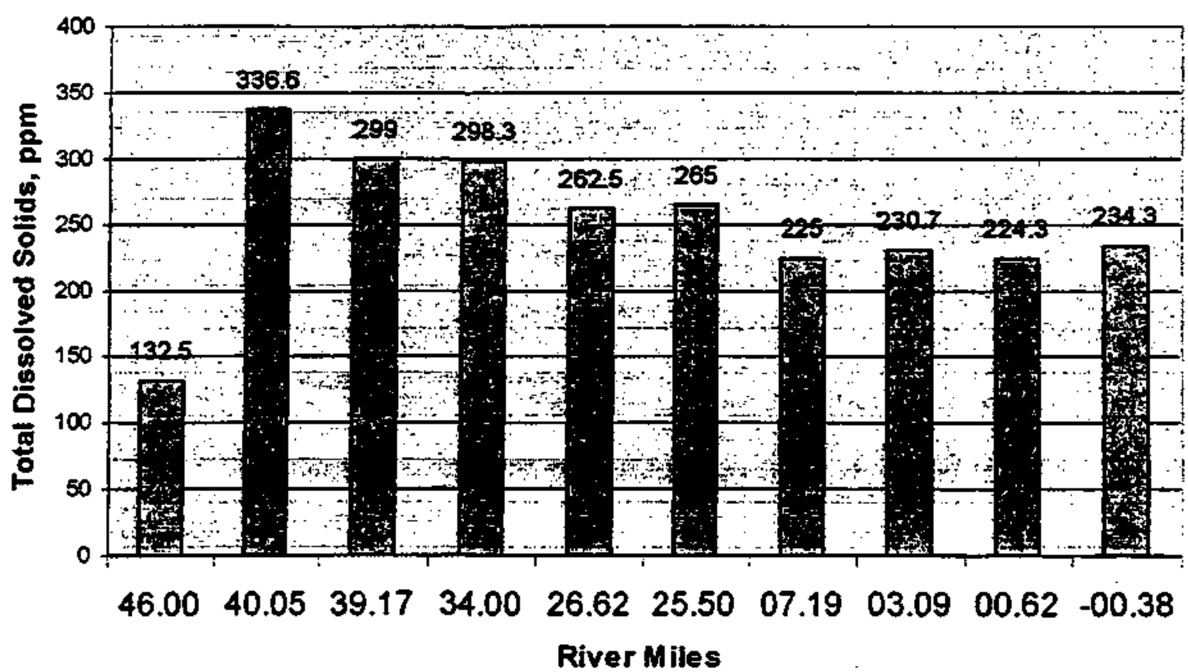


Figure 13
Average Total Dissolved Solids in the West Dolores River

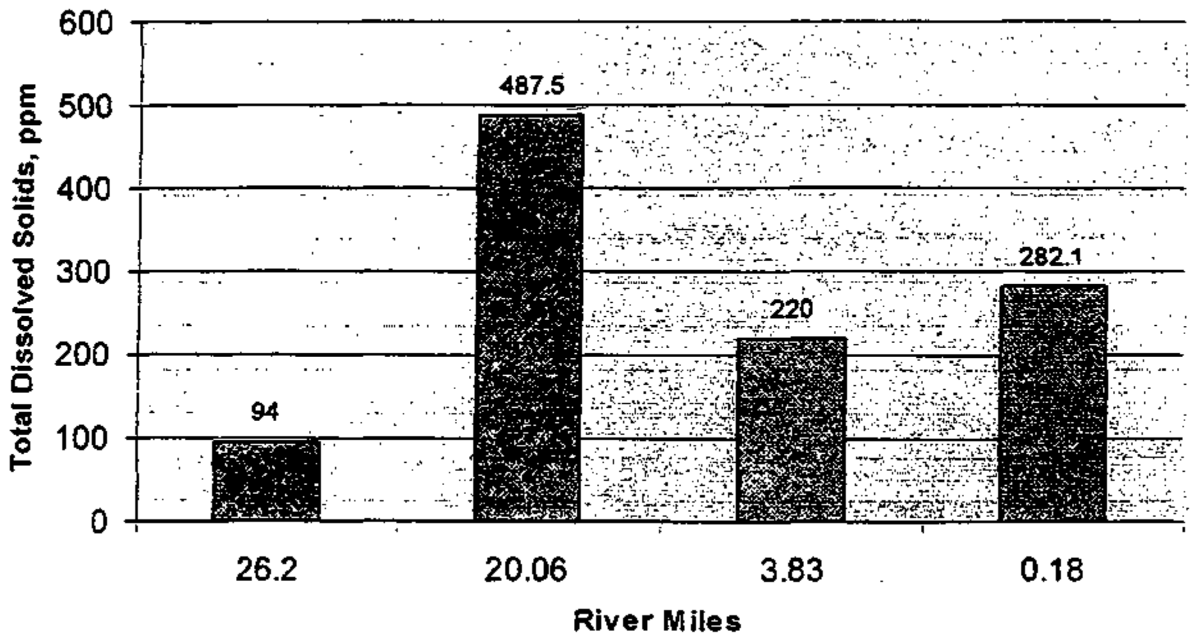


Figure 14
Average Total Dissolved Solids in Silver Creek

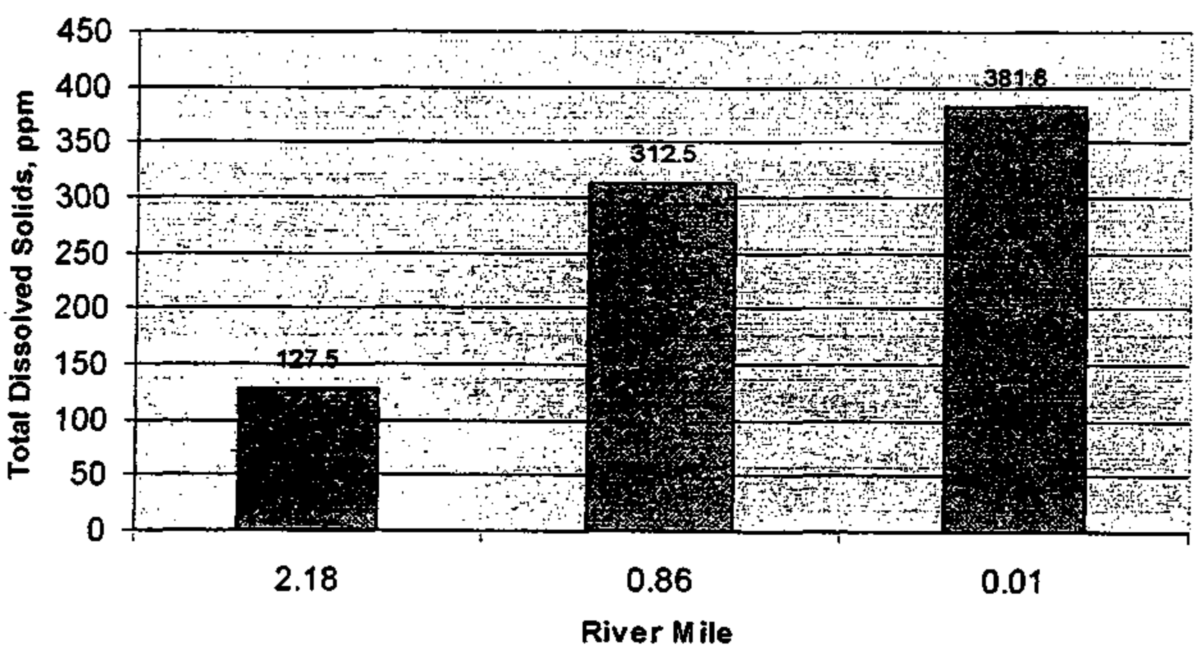
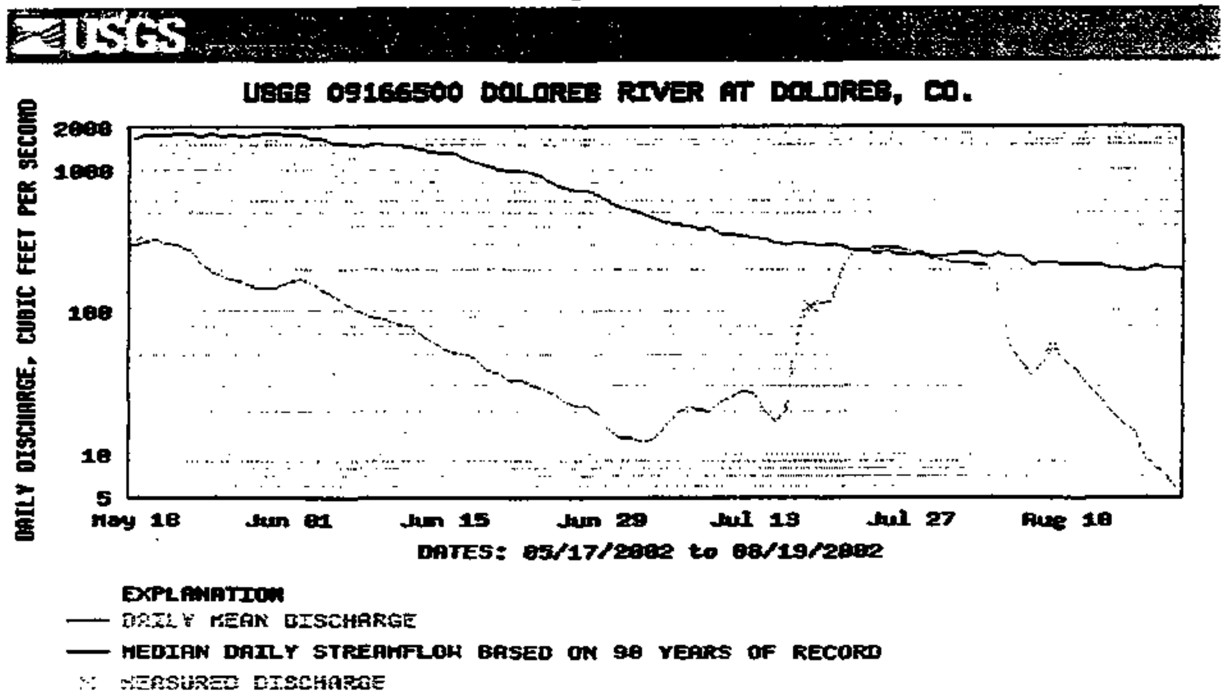
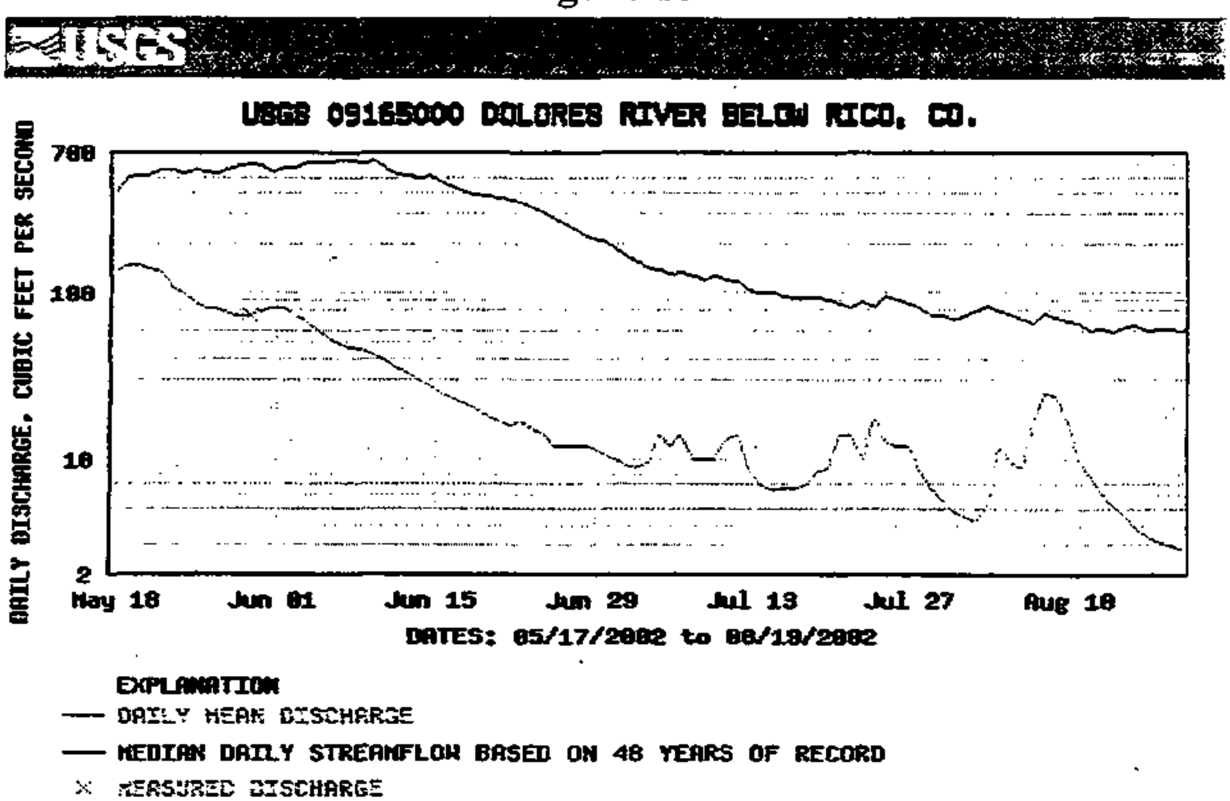


Figure 15



Provisional Data Subject to Revision

Figure 16



Provisional Data Subject to Revision

Figure 17
River Flows Compared to Total Dissolved Solids

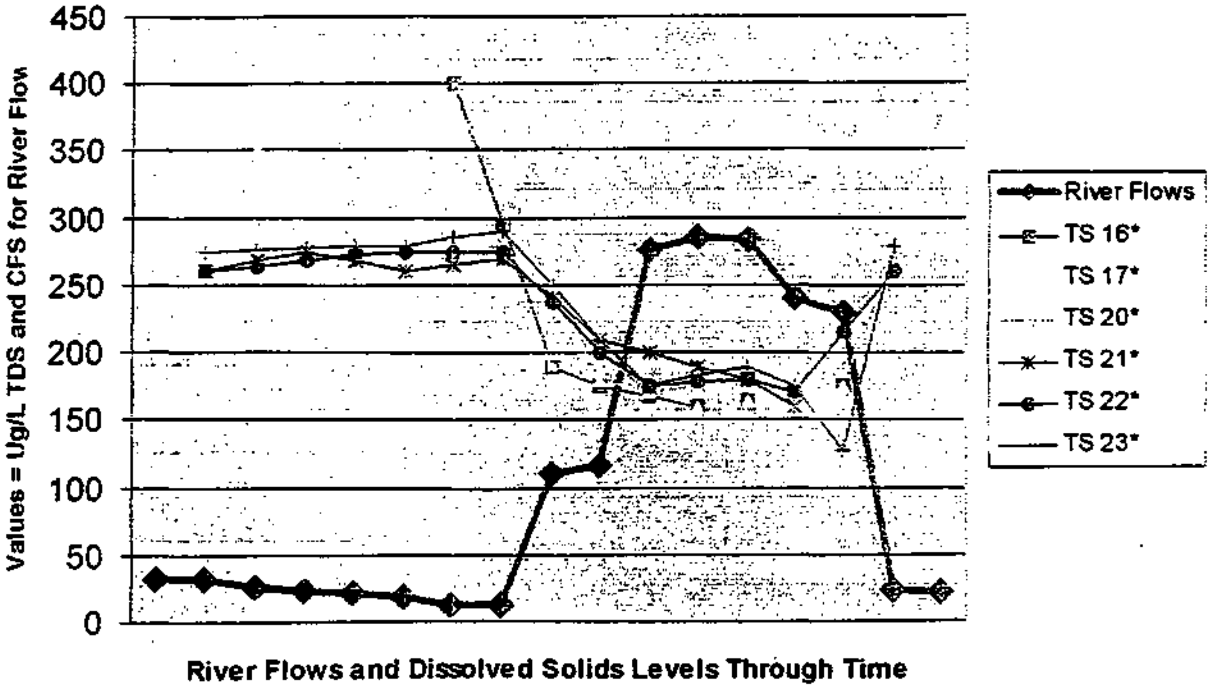


Figure 18
Average Dissolved Elemental Zinc in Silver Creek

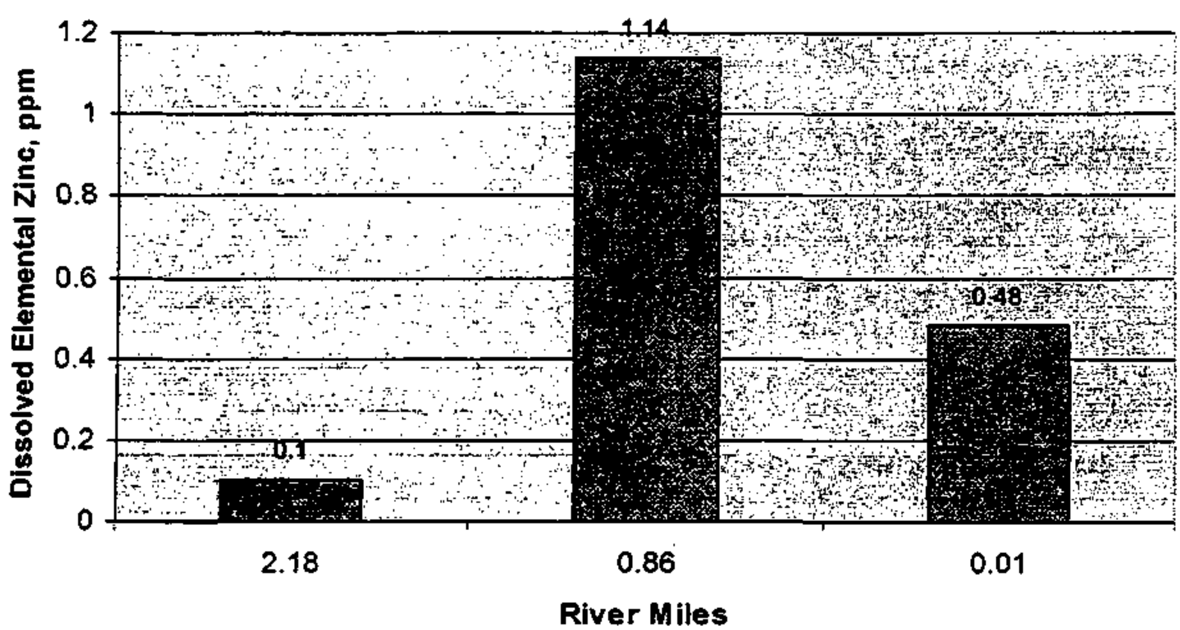


Figure 19
Average pH on Main and East Dolores River

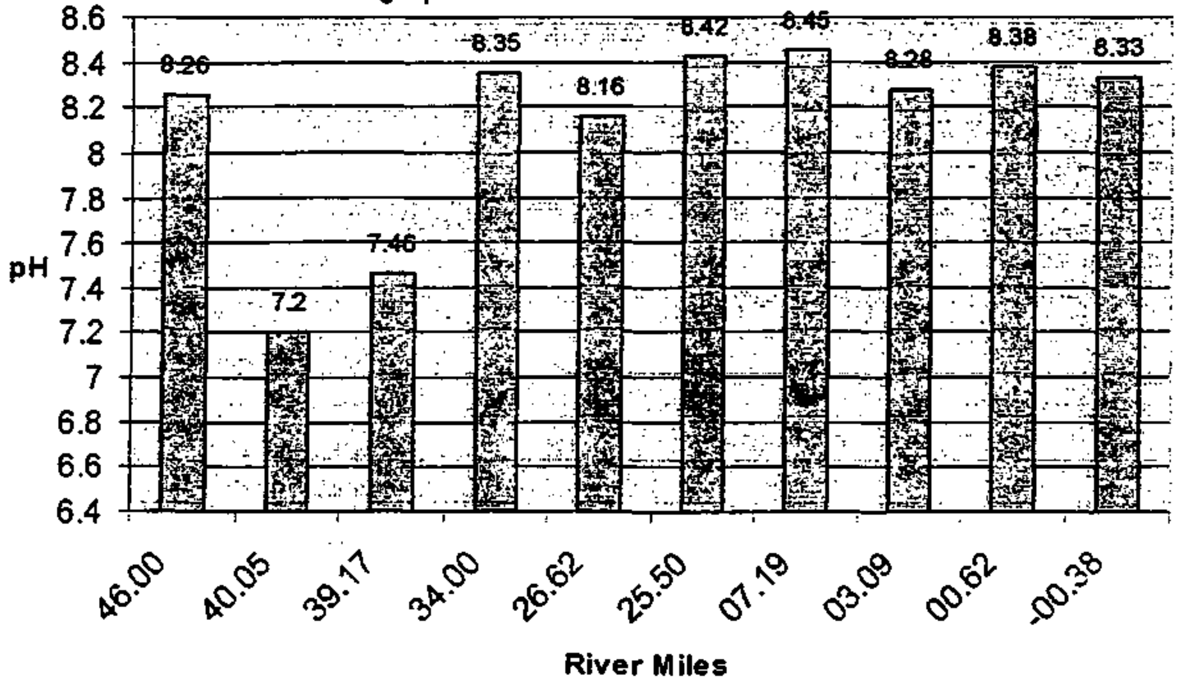


Figure 20
Geometric Mean of Coliform in the West Dolores River

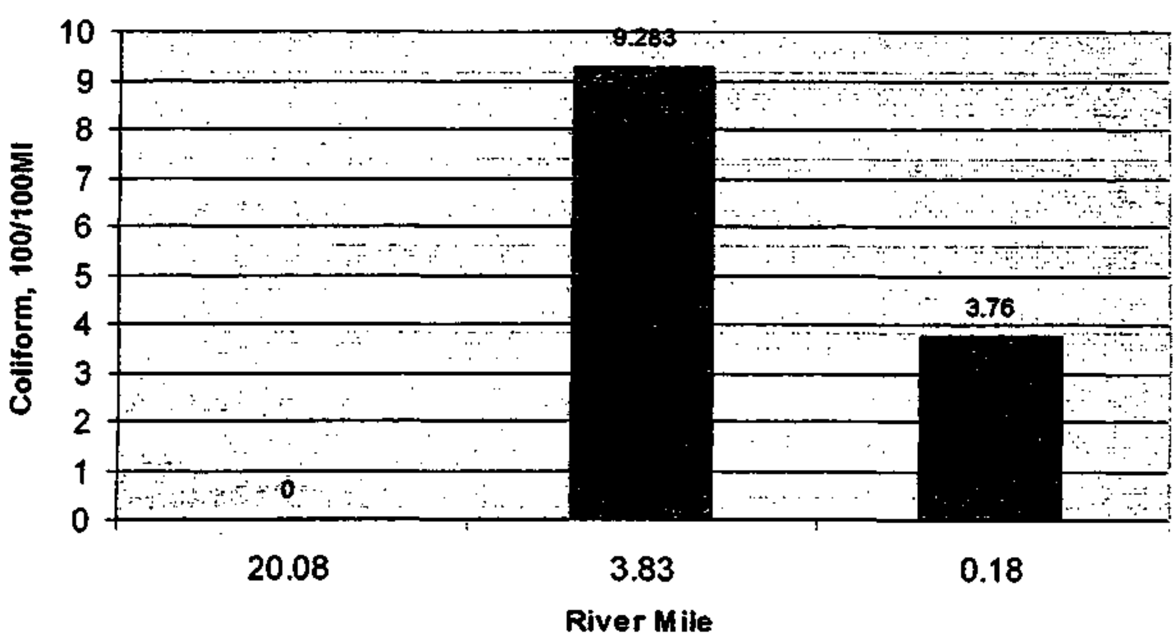
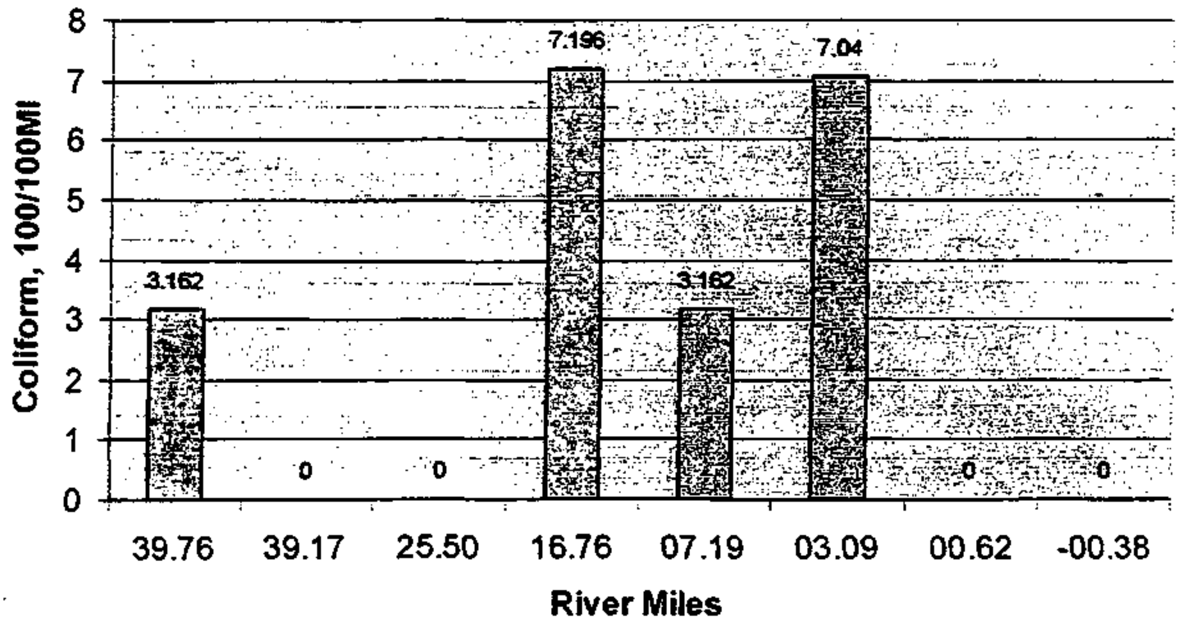


Figure 21
Geometric Mean of coliform in Main and East Dolores River



Appendix E: Total Results

Table 4												
Complete Testing Data												
TS* #	Date/Time	Appearance	PH	Flow at Rico	Flow at Dolores	Temp. C°	Coliform, /100 ml	Zinc, ppm	TDS, ppm	TSS, qualitative	Notes	Remarks
1	6/20/2002	Clear	8.2	17	33	7.4		-	110	none	ClwH	
1	6/24/2002	Clear	8.1	14	27	16.9		-	125	none	SC	
1	7/1/2002	Clear	8.3	9.5	13	8.3		0.1	125	none	Cl	
1	6/28/2002	Clear	8.2	12	19	13.5		0.1	140	none	SCwH	
1	7/17/2002	Clear	8.3	6.9	110	15.7		0.1	150	none	MC	
1	7/24/2002	Muddy	8.2	13	285	18		0.1	140	unmeasurable	SC	RFI
1	7/30/2002	Clear	8.5	4.7	230	18.7		0.1	150	none	C	
1	6/26/2002	Clear	8.3	12	22	10.8		-	120	none	SCwH	
2	6/20/2002	Clear	8.2	17	33	7.3		-	125	none	SCwH	
2	6/24/2002	Clear	8.0	14	27	15.2		-	140	none	SC	
2	7/1/2002	Clear	8.2	9.5	13	9.2		0.1	150	none	ClwH	
2	6/28/2002	Clear	8.1	12	19	11.3		0.1	150	none	SC	
2	7/17/2002	Clear	8.3	6.9	110	11.6		0.1	160	none	C	
2	7/24/2002	Clear	8.3	13	285	17.7		0.1	160	none	PC	
2	7/30/2002	Clear	8.3	4.7	230	16.2		0.1	170	none	C	
3	6/20/2002	Clear	6.5	17	33	43.4		-	2500	none	ClwH	
3	6/24/2002	Clear	6.4	14	27	43.5		-	2500	none	ClwH	AMM
3	7/1/2002	Clear	6.4	9.5	13	43.5		0.4	2500	none	ClwH	AMM
3	6/28/2002	Clear	6.4	12	19	43.3		0.5	2500	none	PCwH	AMM
3	7/17/2002	Clear	6.5	6.9	110	43.1		0.4	2500	none	MC	AMM
3	7/24/2002	Clear	6.4	13	285	-		0.2	2500	none	PC	AMM
3	6/26/2002	Clear	6.5	12	22	43.6		-	2500	none	SCwH	AMM
3	7/30/2002	Clear	6.2	4.7	230	-		0.3	2500	none	PC	AMM
4	6/20/2002	Clear	7.4	17	33	17.4		-	1375	none	ClwH	

4	7/1/2002	Clear	7.2	9.5	13	17.1		0.3	1420	none	ClwH	
4	7/17/2002	Clear	7.3	6.9	110	17.2		1.0	1340	none	C	
4	6/26/2002	Clear	7.2	12	22	18		-	1450	none	SCwH	
4	6/28/2002	Clear	7.4	12	19	18.9		1.0	1620	none	SCwH	
4	7/24/2002	Clear	7.2	13	285	21.2		0.7	1240	none	PCwR	
4	7/30/2002	Clear	7.1	4.7	230	22.1		0.7	1400	none	MC	
5	6/28/2002	Clear	7.2	12	19	16.7		0.1	320	none	SCwH	
5	7/1/2002	Clear	7.2	9.5	13	15		0.1	325	none	SCwH	
5	7/17/2002	Clear	7.3	6.9	110	15.6		0.1	360	none	CwR	
5	6/26/2002	Clear	7.2	12	22	15.7		-	300	none	C	
5	7/24/2002	Muddy	7.2	13	285	21.6		0.1	340	unmeasurable	MC	
5	7/30/2002	Clear	7.1	4.7	230	21.4		0.1	375	none	MC	
6	6/20/2002	Clear	8.2	17	33	7.1		-	110	none	ClwH	
6	6/24/2002	Clear	8.0	14	27	7.4		-	120	none	Cl	
6	7/1/2002	Clear	8.0	9.5	13	9.7		0.1	125	none	PCwH	
6	7/17/2002	Clear	8.2	6.9	110	7.7		0.1	140	none	SC	
6	6/26/2002	Clear	8.0	12	22	8		-	120	none	C	
6	6/28/2002	Clear	8.0	12	19	8.2		0.1	125	none	MC	
6	7/24/2002	Clear	8.1	13	285	11.9		0.1	140	none	CwR	
6	7/30/2002	Clear	8.1	4.7	230	11.9		0.1	140	none	SC	
7	6/20/2002	Clear	8.1	17	33	9.6		-	250	none	ClwH	
7	6/24/2002	Clear	7.8	14	27	10.8		-	250	none	SC	
7	7/1/2002	Clear	7.9	9.5	13	14.3		1.0	320	none	PCwH	
7	7/17/2002	Clear	8.0	6.9	110	11.5		2.0	340	none	CwR	
7	6/26/2002	Clear	8.0	12	22	11		-	290	none	C	
7	6/28/2002	Clear	8.0	12	19	12.5		0.7	290	none	SC	
7	7/24/2002	Clear	8.2	13	285	14.2		1.0	380	none	CwR	
8	6/20/2002	Clear	8.4	17	33	12.8		-	300	none	ClwH	
8	6/24/2002	Clear	8.2	14	27	15.6		-	300	none	SC	
8	6/28/2002	Clear	8.3	12	19	14.6	100	0.7	350	none	PC	

8	7/1/2002	Clear	8.2	9.5	13	16.2	0	0.3	380	none	SCwH	
8	7/17/2002	Clear	8.5	6.9	110	15.8	0	0.5	440	none	MC	
8	7/24/2002	Clear	8.5	13	285	17.6	0	0.5	460	none	C	
8	7/30/2002	Clear	8.4	4.7	230	18.3		0.4	475	none	SC	
8	6/26/2002	Clear	8.4	12	22	14.4		-	350	none	C	
9	6/28/2002	Clear	7.3	12	19	14.5	0	0.1	275	none	CwR	
9	7/1/2002	Clear	7.3	9.5	13	20	0	0.1	320	none	MCwR	
9	7/17/2002	Clear	7.6	6.9	110	12.6	0	0.2	230	none	Cl	
9	7/24/2002	Clear	7.6	13	285	19.2	0	0.1	320	none	C	
9	7/30/2002	Clear	7.5	4.7	230	16.3		0.1	350	none	SC	
10	6/24/2002	Clear	8.2	14	27	11.5		-	250	none	Cl	
10	7/1/2002	Clear	8.3	9.5	13	19.3		0.1	310	none	MCwH	
10	7/17/2002	Clear	8.4	6.9	110	10.8		0.1	325	none	Cl	
10	6/28/2002	Clear	8.2	12	19	15.1		0.1	270	none	C	
10	7/24/2002	Clear	8.6	13	285	19.7		0.1	310	none	MC	
10	7/30/2002	Clear	8.4	4.7	230	14.8		0.1	325	none	SC	
11	6/20/2002	Clear	8.4	17	33	18.6		-	240	none	SCwH	
11	6/24/2002	Clear	8.0	14	27	11.7		-	240	none	Cl	
11	7/1/2002	Clear	-	9.5	13	-		-	300	none	PCwH	TSD
11	6/28/2002	Clear	8.1	12	19	16.2	300	-	270	none	PC	
12	6/28/2002	Clear	8.2	12	19	13.1		0.1	130	none	SC	
13	6/20/2002	Clear	8.4	17	33	21.1		-	175	none	SCwH	
13	6/24/2002	Clear	8.0	14	27	10.3		-	175	none	ClwH	
13	7/2/2002	Clear	8.5	8.8	12	22.4	0	-	160	none	PCwH	
13	7/17/2002	Clear	8.3	6.9	110	11.4	18000	-	175	none	Cl	
13	7/24/2002	Clear	8.6	13	285	20.7	0	-	160	none	C	
13	7/30/2002	Clear	8.6	4.7	230	14.5	0	-	175	none	Cl	
14	6/24/2002	Clear	7.9	14	27	15.2		-	90	none	SC	
14	6/30/2002	Clear	8.1	10	13	10.5		0.2	80	none	SCwH	ZDF
14	7/17/2002	Clear	8.1	6.9	110	12.7		0.1	100	none	C	

14	7/24/2002	Clear	8.1	13	285	11.9		0.1	90	none	SC	
14	7/30/2002	Clear	8.2	4.7	230	15.6		0.1	110	none	MC	
15	6/24/2002	Clear	7.9	14	27	20.9		-	360	none	SC	
15	6/30/2002	Clear	7.9	10	13	16.9	21300	0.2	500	none	SCwHaze	CMW/UNT
15	7/17/2002	Clear	8.2	6.9	110	17.6		0.1	500	none	MC	
15	7/18/2002	Clear	8.1	8.5	116	17.8	0	0.1	525	none	PC	
15	7/24/2002	Clear	8.1	13	285	17.7	0	0.1	490	unmeasurable	CI	
15	7/30/2002	Clear	8.2	4.7	230	26.6		0.1	550	none	SC	
16	6/30/2002	Clear	8.3	10	13	21.3	17200	-	400	none	PC	
16	7/17/2002	Clear	8.4	6.9	110	17.2		-	190	unmeasurable	C	RGR
16	7/18/2002	Clear	8.4	8.5	116	17.7	800	-	175	unmeasurable	PC	RGR
16	7/24/2002	Muddy	8.4	13	285	16.9	0	-	160	unmeasurable	SC	RGR
16	7/30/2002	Muddy	8.4	4.7	230	21.9		-	175	unmeasurable	C	RGR
17	6/20/2002	Clear	8.5	17	33	21.2		-	340	none	SCwH	
17	6/24/2002	Clear	8.2	14	27	12.7		-	350	none	CIwH	
17	6/30/2002	Clear	8.3	10	13	23.4	4600	0.2	390	none	PCwH	ZDF
17	7/18/2002	Clear	8.5	8.5	116	19.5	0	0.1	180	unmeasurable	PC	RGR
17	7/24/2002	Muddy	8.4	13	285	16.8	0	0.1	160	unmeasurable	SC	RGR
17	7/30/2002	Muddy	8.4	4.7	230	16.2		0.1	175	unmeasurable	CIwH	RGR
17	6/27/2002	Clear	8.6	12	22	17.8	200	0.3	380	none	SC	
20	6/21/2002	Clear	8.5	16	33	19.9		-	260	none	SCwH	
20	6/25/2002	Clear	8.2	12	24	18.3		-	275	none	SC	
20	7/2/2002	Clear	8.2	8.8	12	19.5	0	-	280	none	PCwH	
20	7/18/2002	Clear	8.4	8.5	116	15.7	0	-	200	unmeasurable	SC	RGR
20	7/22/2002	Muddy	8.5	10	276	-	0	-	170	unmeasurable	MC	RGR
20	7/25/2002	Muddy	8.8	12	284	23.2		-	180	unmeasurable	MC	RGR
20	7/29/2002	Muddy	8.4	5.5	240	23.6		-	160	unmeasurable	SC	RGR
21	6/21/2002	Clear	8.4	16	33	22.3		-	260	none	SCwH	
21	6/25/2002	Clear	8.2	12	24	21.1		-	275	none	SC	

21	6/28/2002	Clear	8.2	12	19	16.5	0	-	260	none	SCwH	
21	7/2/2002	Clear	8.1	8.8	12	22.3	0	-	270	none	SCwH	
21	7/18/2002	Clear	8.1	8.5	116	16.6	17300	-	210	unmeasurable	SC	RGR
21	7/25/2002	Muddy	8.7	12	284	23.6	0	-	180	unmeasurable	PC	RGR
21	7/29/2002	Muddy	8.3	5.5	240	22.5	0	-	160	unmeasurable	PC	RGR
22	6/21/2002	Clear	8.5	16	33	23.2		-	260	none	SCwH	
22	6/28/2002	Clear	8.2	12	19	16.2	0	0.2	275	none	SC	ZDF
22	7/2/2002	Clear	8.2	8.8	12	21.3	0	0.2	275	none	PCwH	ZDF
22	7/18/2002	Clear	8.3	8.5	116	16.4	0	0.1	200	unmeasurable	CI	RGR
22	7/22/2002	Muddy	8.4	10	276	-	0	0.1	175	unmeasurable	PC	RGR
22	7/25/2002	Muddy	8.8	12	284	23.2		0.1	180	unmeasurable	SC	RGR
22	7/29/2002	Muddy	8.4	5.5	240	22.7		0.1	170	unmeasurable	SC	RGR
22	6/25/2002	Clear	8.3	12	24	22.7		-	260	none	SC	
23	6/21/2002	Clear	8.4	16	33	23.2		-	275	none	SCwH	
23	6/28/2002	Clear	8.2	12	19	16.1	0	-	280	none	SC	
23	7/2/2002	Clear	8.1	8.8	12	23.2	0	-	290	none	CI	
23	7/18/2002	Clear	8.4	8.5	116	16.6	0	-	210	unmeasurable	CI	RGR
23	7/22/2002	Muddy	8.3	10	276	-	0	-	175	unmeasuraable	PC	RGR
23	7/25/2002	Muddy	8.7	12	284	23.6		-	190	-	SC	RGR
23	7/29/2002	Muddy	8.4	5.5	240	23.1		-	175	unmeasuraable	SC	RGR
23	6/25/2002	Clear	8.2	12	24	23.5		-	280	none	SC	
24	7/17/2002	Clear	8.4	6.9	110	12.2	0	-	280	none	CI	
24	7/24/2002	Muddy	8.5	13	285	19.4	0	-	260	unmeasurable	C	RFI
24	7/30/2002	Clear	8.4	4.7	230	16.3		-	290	none	SC	
	7/27/2002	White	6.5	8.5	261	-		0.1	2250	-	CwR	

Database Codes for Appendix E

NOTES CODE	NOTES
C	Cloudy
Cl	Clear
R	Rain
SC	Slightly Cloudy
MC	Mostly Cloudy
PC	Partly Cloudy
H	Hazy
w	with

REMARKS CODE	REMARKS
RFI	River flows increased due to rain
AMM	Value above maximum measurable level on TDS meter
TSD	Testing site discontinued
CMW	Cows muddied water at the testing site
RGR	River flows increased due to releases from Groundhog Reservoir on West Fork
ZDF	Zinc data is likely false due to poor pH control

NOTE ON MODIFIED AND TRANSFORMED DATA ON COLIFORM BACTERIA
Table 4 presents all of the raw counts of coliform bacteria. However they were modified and transformed before being summarized in Table 3 and in the Figures. The modification consisted of deleting the 3 highest numbers on the West Fork, due to cows in the river (CMW). The transformation involved calculating the Geometric Mean of the numbers, instead of the Arithmetic Mean. This is standard practice for coliform bacteria data because the bacteria are highly clumped in their spatial distribution. The logs of the counts are averaged, then the average log is re-transformed into its power of 10, giving the Geometric Mean which more truly represents the average condition.